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Auger Blower Plow Following Truck Equipped with Slice Bar.

SNOW REMOVAL On California Highways

By T. H. DENNIS,
State Maintenance Engineer

IN the winter of 1932-33 the California State Highway Department waged a successful battle against snow on some 3,000 miles of highways. In the succeeding season the front was extended to 3,300 miles.

The cost in 1932-33 was $312,000—an expenditure requiring approximately 17½ cents from the gas tax return made by each of the 1,800,000 motor vehicles in California. Can such expenditures be justified? Let us determine

Traffic Volume and Gasoline Tax.—Snow is removed on 29 state highway routes, which serve in the aggregate some 11,226 vehicles daily during the winter months. Assuming each machine traveled 150 miles, making 14.5 miles to the gallon of gasoline—averages determined in the joint survey conducted by the United States Bureau of Public Roads and the Division of Highways—then the daily return from gas tax would be $3,486 or $313,740 for a conservative winter season of three months' duration.

Open Roads Pay.—Apparently, therefore, the motorists enjoying this service on these particular routes pay their way. Furthermore, if these roads were closed for a three months' period, the interest loss at 4 per cent on some 3,000 miles of road, conservatively estimated to cost $15,000 per mile, would amount to $450,000. Considered from this angle, also, it would appear advisable to keep these routes open.

Let us consider the situation from the standpoint of business. The State Chamber of Commerce is authority for the statement that some $1,500,000 was expended by motorists during the 1931-32 season for transportation alone to winter sports areas, and that this same figure for 1932-33 was nearer $2,000,000. The expenditures for snow sports wearing apparel and equipment, together with the sums spent for meals and lodgings, might conservatively equal, if not exceed, this cost of transportation.

Even assuming the year's expenditure with business at $3,000,000, then a 10 per cent profit on this amount would almost equal the sum invested to make this development possible. Therefore, snow removal from the standpoint of traffic and business interests is economically sound, and its development will continue.

Traffic Safety Provisions.—This work carries with it

Big Blade Rotary Ready for Action.

a very definite responsibility for the proper protection of traffic. It is the view of those in charge that, if an open road is advertised, it must be as safe as conditions will permit. With this in mind, arrangements are made for the placing of hazardous sections of road under control. This phase of the work is handled in cooperation with the California Highway Patrol.

Whenever there are icy conditions, motorists are not permitted to enter the control area unless the vehicles are equipped with skid chains. Likewise, during periods when snow is falling heavily or there is a strong wind with consequent low visibility and danger of temporary blockade, traffic is held up entirely until conditions are favorable for safe passage.

This control is a part of the routine work on the Donner Summit section of U. S. 40, and between Bishop and the State line on State Route 23. Controls are placed in operation at other points as the need arises.

Parking Space Essential.—One of the gravest problems in recreational areas where snow sports are held is the lack of parking space. As a result, when sudden storms occur, our snow equipment is often blocked by locked cars parked along the roadway. This condition might easily jeopardize the safety of all motorists using this particular road. It is our feeling that providing this parking space is the distinct problem of those promoting such snow sports, and their responsibility is indeed a real one.

Effects of Altitude and Topography.—Most of the snowfall is above the 2,000-foot elevation, but an occasional freak storm descends to lower altitudes. At such times all available maintenance blade equipment must be pressed into service. A considerable portion of the mileage cleared is above the 5,000-foot elevation, and it is on these sections that difficulties are encountered and the major expense incurred.

This is particularly true on U. S. 40, between Auburn and Truckee; the Crestline Road, State Route 43, east of San Bernardino; and State Route 23, between Bishop and Bridgeport. Snow is removed on these roads at elevations in excess of 7,000 feet and, due to the lack of forestation, drifting constitutes one of the main difficulties. Miles of snow fence are required, but its effectiveness is continually impaired by the vagaries of the wind currents, side-hill cuts over deep canyons being particularly bothersome.

Maintenance of Men and Equipment.—One or two light storms are expected any time after October 15, with the first heavy snowfall coming about a month later. Normally, the crews must be kept organized and all equipment held available until March 15. After that date, there will be occasional storms of short duration. Most of the equipment is then available to open up roads allowed to close over the winter.

Early in the snow removal work in California; it was realized that successful snow removal at the higher elevations depended on proper equipment, adequate shop facilities, and comfortable living quarters. Every winter season, storms of several days' duration may be expected. Equipment must be in operation practically continuously from the start of the storm until it ceases and the road is clear. Any delay on account of breakdown or insufficient equipment makes it more difficult to keep an open road.

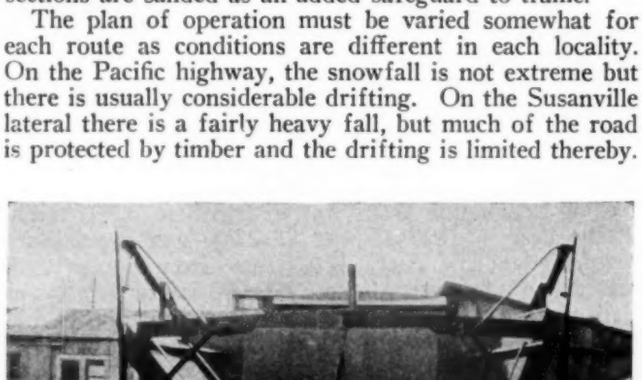
The continuous operation in bucking snow under low temperature conditions is a severe strain on equipment, and, in order to properly service it and make necessary repairs, well heated quarters and complete shop equipment and facilities are provided in the heavy snow areas. Likewise, an eight-hour trick at the wheel of a truck plowing snow is a strain on a man, and warm, comfortable quarters, with facilities for serving hot meals at any hour of the day or night, are provided at such locations.

Four Donner Stations.—On the Donner Summit route, there are four maintenance stations which serve as headquarters: One at Colfax, from which equipment normally operates to Baxter's; one at Yuba Pass, three miles east of Emigrant Gap, which serves the section from Baxter's to about nine miles east of Yuba Pass; one at Donner Summit, which covers the section to the east of Donner Lake; and one at Truckee out of which the equipment is operated east to the State line, south to Tahoe City, and this year will take care of the new secondary road to Hobart Mills. The equipment is shifted as the need develops.

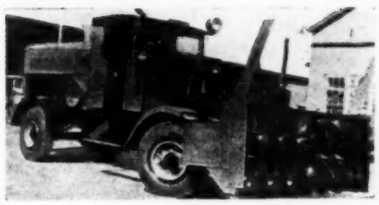
Plan of Operation.—The plan of operation is as follows: With the start of a storm, the one-way push plows, which are mounted on 3½ to 5-ton four-wheel drive trucks, are on the road pushing the snow into a windrow at the side of the pavement. A rotary plow is put in operation as soon as sufficient snow has been bladed to the side and the windrowed snow is thrown clear.

As the snow accumulates into a high bank alongside the roadway, it is necessary to use a slicer bar mounted on the side of a truck to slope back the bank. The snow brought in with the slicer bar is then thrown clear by the rotary equipment. At the expiration of a storm, icy sections are sanded as an added safeguard to traffic.

The plan of operation must be varied somewhat for each route as conditions are different in each locality. On the Pacific highway, the snowfall is not extreme but there is usually considerable drifting. On the Susanville lateral there is a fairly heavy fall, but much of the road is protected by timber and the drifting is limited thereby.



A Widening Rotary on Semitrailer.



Auger Blower

On the road between Bishop and the State line there is a considerable mileage at about 8,000-foot elevation. The snowfall is not extremely heavy but the snow is dry and, with a strong wind, the road drifts full in a few minutes.

It was found last season that on this particular route, push plows of the "V" type would serve to better advantage as they can be operated at higher speed and break through drifted snow more easily than the one-way speed plows, although they are not so effective for widening operations.

Plans are made to work the crews on an 8-hour basis, although in emergencies it is sometimes necessary to extend the day's work to 12 hours.

Plow Types for Varied Operations.—The State now has more than 170 snow plows of various types. These plows are of all types, from the light "V" plows on motor graders, light one-way push plows for 2-ton trucks, one-way and "V" plows for 3½- to 5-ton trucks, tractor push plows, tractor rotary plows, and truck rotary plows.

The truck rotary plows are of four types, as follows: One consists of a regular "V" type plow augmented by revolving wheel equipped with small buckets, the wheel being mounted on a movable arm, which may be moved back and forth or up and down in front of the truck at the will of the operator. On the other type, the revolving blades are on a shaft fixed to the "V" plow and simply throw the snow as the "V" pushes it to the side. This equipment may be removed and the trucks made available for other work.

The third or auger blower type consists of two long augers mounted parallel to the road surface. The revolving augers break up the snow and throw, rather than blow, it to the side through a chute. The fourth type is a large diameter wheel with several fixed blades. The outfit is mounted on the rear of the truck, which is operated backward into the snowdrift. This plow is on the principle of railroad rotary plows.

There is also the widening rotary, which is mounted on a trailer unit, having an independent power plant to operate the blade rotary. The rotary is mounted at the front of the trailer and can be swung in an arc to operate either side of center.

Rotary type plows are operated in areas of either heavy snowfall or where drift conditions are prevalent. The heavy "V" and push plows, straight or reversible, are usually used in conjunction with the rotaries, handling the storm until all available storage space is exhausted. The lighter push plows are operated at the lower elevations where the snowfall is light and does not pack on the ground for any long period. Where drift conditions are absent, often a light truck-mounted plow with side-wing attachment will handle snow areas where the season's fall does not exceed six feet.

Snow Fences.—In addition to the removal work, a considerable amount of snow fence has been installed. Some of this fence is of our own design patterned after that used by railroad companies and installed permanently in place. Most of the fencing is of the lath type, however, as it is cheaper to install, easier to move, and, in the main, is more effective. In some cases, considerable experiment is necessary to determine the proper location for this fence to insure the desired protection to the roadway.

Costs.—The cost of snow removal per mile of road is reduced by the use of proper equipment. It is difficult to compare one season with another exactly, as the amount of snowfall, duration of storms, wind, and similar conditions have a bearing. During the 1931-32 season, the average cost of the work on 2,480 miles of road was $124 per mile. During the 1932-33 season, the average cost per mile was $104 on 3,000 miles of road. The snowfall on these roads ranged from 48 inches to 533 inches for the season. The cost of snow removal for the entire system for the 1932-33 season was $312,000, distributed as follows:

Materials and supplies	18.8%
Service and expense	9.0%
Salaries and wages	36.6%
Equipment rental	35.6%

The equipment is all owned by the State, but is charged to the work on the basis of a rental rate per shift or month as the case may be. This rate is established by the equipment department and covers depreciation and upkeep but no operating charges.

Snow removal presupposes that the roadway is improved so that traffic will have no difficulty once the road is open. Likewise, it is necessary, that the road alignment and surface shall be favorable for the operation of equipment.

Acknowledgment—The foregoing is a slight condensation of an article in California *Highways and Public Works.*

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Progress on Public Works Highways to August 18, 1934

Progress made on emergency construction of public works highways to August 18 under the supervision of the U. S. Bureau of Public Roads shows a total of 345 projects, estimated to cost $16,858,000, approved but contracts not yet awarded; 288 projects, estimated to cost $10,199,000, awarded but not yet under construction; 3,944 projects, estimated to cost $246,080,000, under construction; and 3,855 projects completed at a cost of approximately $140,689,000.

The 3,944 projects under construction involve 11,095 miles of road and are giving regular direct employment to 267,227 men.

The above figures include projects involving funds provided by the Acts of June 16, 1933, and June 18, 1934.

Graham Hunter in "The Highway Magazine"

COMPRESSION TESTING OF CONCRETE BEAMS FROM FLEXURE TESTS

THE practice of making flexure tests upon concrete for use in pavements is now almost universally established. In addition to the modulus of rupture strength, most engineers, however, also desire to secure the compressive strength of the concrete. The Kansas Highway Commission has for several years been determining the compressive strength of the concrete on paving jobs by sending in to the main laboratory portions of the specimens broken in flexure, the ends of which are cut square by a silicon carbide saw. The prisms are then capped and tested in compression. Some states have followed a similar procedure, while other states have continued to make the standard 6 by 12-in. cylinders along with the flexure specimens. Others have drilled out cores or ground down beam ends and made compression tests.

About four years ago, it came to the attention of Prof. C. H. Scholer that in some European laboratories it was common practice to make compression tests upon portions of beams from flexure tests (as modified cubes). The Road Materials Laboratory of the Engineering Experiment Station of Kansas State College, in cooperation with the Kansas Highway Commission, has been making a rather informal investigation of this method and the results presented by L. H. Koenitzer, Instructor, Applied Mechanics Department, Kansas State College of Agriculture and Applied Science, Manhattan, Kans., in a paper presented at the recent 37th annual meeting of the American Society for Testing Materials. An abstract of the paper follows:

In recent years, it is becoming accepted practice to make flexure tests on concrete used on paving projects. As yet, the engineering profession does not have enough information on flexure tests to warrant their exclusive use in the design of concrete mixtures. Highway departments that make flexure tests either make 6 by 12-in. cylinder specimens from the same batch of concrete for compression tests, or use silicon carbide saws to saw the ends of the flexure specimens off square, making prism specimens which are tested in compression.

To eliminate the necessity of buying expensive sawing equipment and extra labor required in making additional specimens, the author has attempted to perfect a suggested method of compression testing on the broken flexure specimens, the results of which compare very favorably with compression tests made in the standard manner on 6 by 12-in. cylinders. This method has been checked and found satisfactory by using transparent models in photo-elastic equipment.

Materials.—Two mixes were used: one consisting of sand-gravel (mixed aggregate) aggregate, and the other mix consisting of fine aggregate and limestone aggregate. The materials all met the specifications for Kansas highway pavement. Ordinary portland cement was used with the sand-gravel mix and an early-strength cement was used in the coarse-aggregate mix. A water-cement ratio of 5 gal. of water per sack of cement was used for the sand-gravel mix and 5.25 gal. of water for the coarse-aggregate mix. All tests were made on typical paving mixes.

Test Methods.—The 6 by 12-in. cylinder compression specimens were made in accordance with the A.S.T.M. Standard Methods of Making Compression Tests of Concrete (C 39).[1] The 6 by 6 by 36-in. beam specimens were made in accordance with the A.S.T.M. Tentative Laboratory Method of Making Flexure Tests of Concrete Using a Simple Beam with Center Loading (C 78 - 30 T).[2]

The beams were broken in flexure in a simple-beam testing machine,[3] loaded at the center of an 18-in. span. The specimens were broken at the ages of 4 and 10 days, which is common highway practice.

After the beam is tested in flexure in the field, one, two, or three pieces (depending upon the number of compression tests desired) are sent to the testing laboratory where a 300,000-lb. compression machine is available. The portions of the beam are capped on the sides (not the top or bottom of the beam as it is molded) with a mixture of one part cement and one part plaster of Paris so that there shall be two smooth surfaces directly opposite each other, each surface being at least 7 in. in length and the full width of the specimen. It is recommended that machined cast-iron plates be used to place the specimen on while the cap is being formed.

After capping, the specimens are placed in the moist room until time of testing when they are tested in a 300,000-lb. compression machine. The specimen is placed in the machine with 6 by 6-in. bearing plates on the top and bottom directly opposite one another; thus the specimen is tested as a modified cube having the load applied over a 6 by 6-in. area, and a depth of 6 in. (if the beam originally was 6 by 6-in. in cross-section) with a short overchanging portion of the specimen on each side of the plates. The length of projection be-

[1] 1933 Book of A.S.T.M. Standards, Part II, p. 230.
[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 30, Part I, p. 1027 (1930); also 1933 Book of A.S.T.M. Tentative Standards, p. 440.
[3] *Proceedings*, Am. Soc. Testing Mats., Vol. 30, Part II, p. 589 (1930).

TABLE I.—SAND-GRAVEL AGGREGATE CONCRETE

	Compressive Strength				
Specimen	Cylinders,[1] lb. per sq. in.	Prisms, lb. per sq. in.	Variation from cylinders, per cent	Modified cubes,[1] lb. per sq. in.	Variation from cylinders, per cent
No. 1.....	4598	3917	—14.8	3666	—20.6
No. 2.....	4350	3472	—20.4	3805	—12.5
No. 5.....	3714	3306	—11.0	3792	+ 2.1
No. 6.....	3466	3472	+ 0.2	3930	+13.4
No. 9.....	4386	4167	— 5.0	4305	— 1.8
No. 12....	4032	3889	— 3.5	3504	—13.1
No. 13....	3501	4944	+41.4	3528	+ 0.8
No. 16....	2900	2906	— 3.2	2944	+ 1.5
No. 17....	3006	2444	—18.7	3222	+ 7.2
No. 20....	3148	2750	—12.6	3230	+ 2.6
No. 21....	3466	3056	—11.8	2611	—24.7
No. 24....	3289	2861	—13.0	3458	+ 5.1
No. 25....	3466	3083	—11.0	3097	—10.6
No. 28....	3572	3139	—12.5	3000	—16.0
No. 29....	3431	3444	+ 0.4	3625	+ 5.1
No. 37....	5135	4070	—20.8	4410	—14.1
No. 38....	4740	4310	— 9.1	4775	+ 0.7
No. 39....	5040	4440	—11.9	4715	— 6.4
No. 40....	4425	4550	+ 2.8	4720	+ 6.7
No. 41....	4080	4265	+ 4.5	4172	+ 2.3
No. 42....	3770	4580	+21.5	4452	+23.4
No. 43....	4052	3500	—13.6	3388	—16.4
No. 44....	3468	3315	— 4.4	3744	+ 8.0
No. 45....	3477	3790	+ 6.1	4168	+19.9
No. 46....	3945	3230	—18.1	3513	—11.0
No. 47....	3025	3240	+ 7.1	3772	+24.7
No. 48....	3730	3610	— 3.2	3832	+ 2.7
No. 49....	4855	3490	—28.1	4962	+ 2.2
No. 50....	5030	4550	— 9.5	4695	— 6.7
No. 51....	5115	3930	—23.2	4992	— 2.4
No. 52....	5085	5280	+ 3.8	5150	+ 1.3
No. 53....	5270	5210	— 1.1	5470	+ 3.8
No. 54....	4935	5140	+ 4.2	5110	+ 3.5
Average	4044	3795	— 5.7	3993	— 0.6

[1]Each value is the average of two specimens.

yond the plates has been from 1 to 3 in. In every case an effort has been made to have this projection symmetrical on each side. The photo-elastic analysis, however, does not indicate that this is important.

Discussion of Data.—The specimens in almost every case break up into a cone and fragments.

The results of Mr. Gonnerman[4] show that at the age of 28 days 6-in. cubes are 16 per cent stronger than 6 by 12-in. cylinders. This does not hold true for a comparison of the modified cube method suggested above, and 6 by 12-in. cylinders. The data in Table I indicate that it is not necessary to apply a correction factor when comparing the compression tests on 6 by 6-in. modified cubes, and 6 by 12-in. cylinders. The average strength of the 66 modified cubes made of sand-gravel aggregate was 3,993 lb. per sq. in. as compared with 4,044 lb. per sq. in. for the 66 6 by 12-in. cylinders.

The average strength of 33 prisms was 3,795 lb. per sq. in. These averages are based upon specimens made from the same batches of concrete, and the individual comparison between specimens can be made by considering that the specimens on each line (Table I) are made from the same batch of concrete.

For a coarse-aggregate concrete mix the average strength of 26 6 by 12-in. cylinders was 3,994 lb. per sq. in. (Table II), and the average strength of 26 modified cubes from the same batches of concrete was 4,008 lb. per sq. in. Prisms sawed out of the same flexure specimens from which the modified cubes were taken show a strength of only 3,664 lb. per sq. in., which is 8.8 per cent less than the strength of the corresponding cylinders.

[4] H. F. Gonnerman, "Effect of Size and Shape of Test Specimen on Compressive Strength of Concrete." *Proceedings*, Am. Soc. Testing Mats., Vol. 25, Part II, p. 248 (1925).

[5] Photo-elasticity by Coker and Filon.

The strength of the modified cubes corresponds very closely to the strength of 6 by 12-in. cylinders. The modified cube method gives much better results than the prisms when compared to the standard cylinder specimens. In fact, there is a closer relationship between the strength shown by cylindrical specimens and the modified cube specimens than is shown between the cylinders and the prisms. Tests on over 300 modified cubes which were not capped indicate that regardless of the apparent condition of the sides of the beams it is always necessary to cap both sides of the broken flexure specimen before testing in compression. Modified cubes, not capped, were 8 per cent lower in strength than the capped standard 6 by 12-in. cylinders, while capped modified cubes varied only 1.25 per cent from the standard cylinders.

Photo-Elastic Analysis.—A photo-elastic analysis of the modified cube method indicates that the maximum shearing stresses[5] are fairly constant regardless of whether there is only a slight overhang or whether the load is applied at the center of the specimen with an overhang of two to three times the depth of the specimen.

The most important things brought out by the photo-elastic analysis are that the bearing faces of the specimen being tested have plane smooth caps or faces, that the spherical bearing block is in good working condition, and that the load is applied perpendicular to the capped surface of the specimen. In spite of the polishing done on the bakelite used in the photo-elastic apparatus, the material showed irregular stresses on both surfaces of the specimen. The result of not centering the specimen under the application of load shows an unequal distribution of stresses.

Summary.—1. The length of projection of the ends of the beam past the bearing plates appeared to have no effect upon the strength of the modified cube.

2. The modified cube method requires less labor, less expenditure for maintaining equipment, and less equipment than is required to test specimens as prisms or cores.

3. The strengths obtained by the modified cube method are closer to the strength of the standard 6 by 12-in. cylinders than are the strengths of the prisms.

4. The photo-elastic analysis indicates that the stress distribution is essentially the same regardless of the amount of overhang on each side of the bearing plates.

5. The photo-elastic analysis indicates that it is impossible to get caps smooth enough so that there will be a uniform distribution of stresses without small concentrated stresses near the surface of the specimen.

6. The photo-elastic analysis emphasizes the impor-

TABLE II.—COARSE-AGGREGATE CONCRETE

	Compressive Strength				
Specimen	Cylinders,[1] lb. per sq. in.	Prisms, lb. per sq. in.	Variation from cylinders, per cent	Modified cubes,[1] lb. per sq. in.	Variation from cylinders, per cent
No. 61....	4200	3420	—18.7	3735	—11.1
No. 62....	3820	3310	—13.4	3695	— 3.3
No. 63....	3140	3000	— 4.5	4345	+38.4
No. 64....	3460	3810	+10.1	4080	+17.9
No. 65....	3990	3440	—13.8	3860	— 3.3
No. 66....	4030	4190	+ 4.0	3570	—11.4
No. 67....	3530	2860	—19.0	2950	—16.4
No. 68....	3670	2920	—20.5	3200	—12.8
No. 69....	3790	3250	—14.3	3350	—11.6
No. 70....	4749	4220	—11.1	5117	+ 7.7
No. 71....	4925	4705	— 4.5	4967	+ 0.8
No. 72....	4155	4092	— 1.5	4466	+ 7.5
No. 73....	4460	4149	— 7.0	4775	+ 7.1
Average	3994	3664	— 8.8	4008	+ 0.7

[1]Each value is the average of two specimens.

tance of getting the specimen accurately centered under the load so as to prevent an uneven distribution of stresses in the specimen. Highly concentrated stresses give low values not indicative of the true strength of the specimen.

7. The adoption of the modified cube method of testing makes it practical to make compression tests on beam specimens after they have been tested in flexure, without the purchase of additional equipment.

8. It is suggested that the modified cube method of making compression tests be given further study to determine its suitability for use on highway projects so as to further the gathering of valuable data on the relationship between flexural and compressive strengths of concrete mixtures.

Acknowledgment.—The author is indebted to Prof. C. H. Scholer, Director, Kansas Highway Testing Laboratory, Manhattan, Kans., for his valuable suggestions in connection with this research project. The author is also indebted to H. Allen, Materials Engineer, Kansas State Highway Commission, for the preparation of the prism specimens.

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Medina County's Stage Construction of County Roads

By R. E. House

County Engineer, Medina, Ohio.

In the year 1925, Medina County, Ohio, had a total road mileage of 816.0 miles, of which 608.72 miles were earth or dirt roads. The State system included 110.2 miles, while the County and Township had 705.8 miles of road under their care; 86 per cent of the total mileage being unimproved.

On December 31, 1933, there were 197.38 miles of unimproved earth roads; only 23.7 per cent of the roads being in a condition not acceptable to the demands of the average motorist.

In November, 1925, Medina County voted a 2-mill levy to run for five years, for the purpose of building secondary or feeder roads. At that time the County Commissioners pledged the use of the proceeds equally in all townships.

The program started in 1926, when approximately 20 miles were constructed. During the five years that the 2-mill levy was effective, it paid approximately 40 per cent of the total cost. During this 5-year period, property owners' assessments at the rate of $2,000.00 per mile raised approximately 36 per cent of the cost. The assessment was levied against each residence at the flat rate of $100.00, and the balance was placed on the abutting real estate in proportion to the valuation of each parcel, as shown on the tax duplicate. The balance of the cost, or approximately 24 per cent, was paid in by each township.

During the 5-year period, the grubbing, clearing, grading of the roadway, borrow excavation, finishing shoulders, preparing drives and approaches, construction and extension of culverts and the construction of bridges was done by the County except in a few cases. The puchase and application of all surface material was let by contract. Guard rails were placed where necessary on all roads. Warning signs were erected at all curves and road intersections.

The general specifications of the State Highway Department prevailed on all road construction. Eighteen hundred to 2,000 cubic yards of gravel, stone or slag were spread on the road to a width of 14 feet with a cushion of about 1 inch, the balance placed on the berms in windrows to be pulled in as needed. Traffic was maintained during the widening of the roads.

All maintenance work, i. e., cleaning ditches, maintaining berms, mowing weeds and placing additional amounts of material, has been done with County forces, the cost being absorbed from the proceeds of the gas tax and auto license fees.

1930 being the last year for the 2-mill levy, and more than 350 miles of road being still unimproved, leaving hundreds of people still in the mud, a 1½-mill levy was voted to run for three years.

In 1932, the first year that the proceeds of the 1½-mill levy were available, the program was drawn up as usual, except that it was on a reduced basis in that the reappraisal of real estate by the auditor of 1931 had reduced the tax duplicate from 60 million dollars to approximately 41 million, which reduced the income in addition to the reduction of the ½ mill.

During this period, the roads were constructed as during the 5-year period of the 2-mill levy. An agreement was drawn up between the County Commissioners and the Trustees of each Township to the effect that when an amount of material had been placed by the trustees, in addition to that placed the first year, which would make the roads acceptable to the Commissioners and County Surveyor the roads would then be formally taken over for maintenance by the County. In the meantime the County was to do all maintenance other than placing additional material.

Under this plan, in 1932 approximately 45 miles of traffic bound roads were constructed. The 1933 program completed about the same number of miles.

It is estimated that at the end of 1934, at which time the proceeds of the 1½-mill levy will have ended, there will be only 170 miles of earth roads left in Medina County, many of which will probably never need improvement. Eighty per cent of all roads in the county will thus be suitable for modern automobile travel. Medina County's secondary road system will then consist of approximately 480 miles of traffic bound roads, with 47.40 miles of hard surfaced roads, and the State system will be about 130 miles. Of the total improved roads in the county, outside of the state roads, approximately 380 miles will have been improved during the 8 years of the special road levies.

The initial cost of construction of the 380 miles over the 8-year period will have been approximately $1,780,000.00 or an average cost of $4,684.21 per mile. The average cost of grading per mile has been somewhat less than $1,000.00, not including the construction and repair of bridges and culverts, which was done by the bridge department.

STATISTICAL DATA MEDINA COUNTY

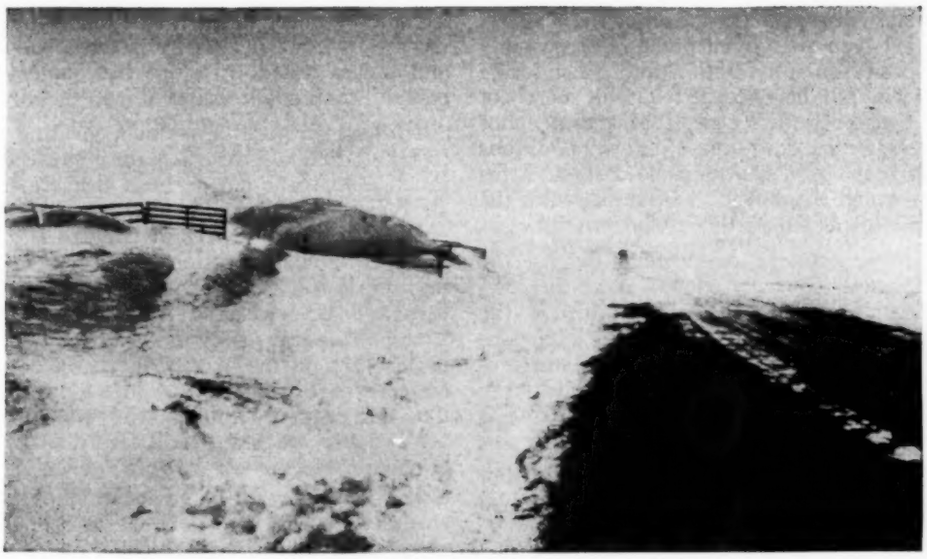
Population 1930—29,677.

Comprised of 17 townships with a combined area of 416 square miles.

Tax Duplicate including Real Property and Public Utilities (approximately):

1930—60 million dollars.
1931—41 million dollars.
1932—40 million dollars.
1933—35.2 million dollars.

Within the borders of Medina County is a large section of the Cleveland Metropolitan Park system, also a natural body of water, Chippewa Lake, which is a very popular summer resort and amusement center.



A Road Kept Open by Sectional Fence Set on Top of Drifts

SNOW CONTROL IN WYOMING

Fencing, Removal, Location, History, Organization

By GEORGE W. MARKS

District Engineer, Wyoming State Highway Department, Rawlins, Wyoming

DURING the past two decades, the taxpayers of this country have invested millions of dollars in their highways. The only dividends they can expect on this investment is highway service and any time this service is interrupted, dividends cease.

In the northern states and in the mountainous sections of all the states, winter storms are a source of danger to any who may have occasion to use the public highway. With the modern inclosed car, which is usually equipped with some kind of heater, there is little to fear as long as the road is open, visibility is fair and proper judgment is used in driving. However, when the roadway is covered with snow or portions are obstructed by drifts, it is not only hazardous but often useless to try to drive until these obstacles are removed.

In order to insure the traveling public, safe, uninterrupted communication during the winter months at reasonable costs, it is necessary that the various highway organizations have a knowledge of the means of controlling the action of snow. We are not likely to find any way of preventing its falling or drifting but we can control this to a certain extent by location, drift control, and snow removal.

Many snow problems are common to all parts of the country and the methods used to solve them are quite similar. Some problems are peculiar to limited sections and some solutions adaptable only to certain localities. The methods used in a thickly settled region might not prove satisfactory in an unsettled locality. A section where precipitation is heavy will require a different technique from that used in arid regions. High and low altitudes require different treatments and in this region where high winds prevail, few rules apply.

Problems of the Intermountain Region.—It is my opinion that in this intermountain region, we have problems that are not common to many other sections. True we do not have dense traffic nor is our precipitation generally very heavy but we do have every kind of weather. It knows no rules of conduct and is about as dependable as a politician's promise. We have everything from absolute desert to perpetual snow; large areas covered with virgin timber and treeless plains; sections where it seldom blows and others where it seldom stops; places where it is hard to locate a road where it would be possible to get a car with a long wheel base around the curves, and places where it is possible to locate a tangent as far as you can see; locations where shelter may be obtained at a reasonable distance but in most instances, shelter other than you can provide for yourself is virtually non-existent.

Here storms are frequent and weather bureau predictions unreliable. Most of the people of this region depend on the roads for intercommunication. Railroads are few and far between. It is up to the various highway organizations to see that these means of communication are not interrupted and a great deal depends on their knowledge of snow control if their efforts are to be successful.

The study of snow control starts with the first reconnaissance and is present through all the stages of location, construction, and maintenance.

Highway Location to Avoid Drifts.—Highway location is a science, the knowledge of which is possessed to a greater or less extent, by every adult American citizen. The fact that there is a wide difference of opinion on every phase, particularly snow control, does not in the least detract from this self-confidence.

Be this as it may, the locating engineer cannot afford to ridicule or ignore the opinion of those who are familiar with the country through which he proposes to locate. The information he may get is usually incomplete and may be influenced somewhat by self interest but never-

theless it is valuable. His problem is to get the shortest practicable route between two given points. He usually has a limited amount for construction and must locate so that this sum will not be exceeded but he must not forget that after construction is completed, maintenance is a factor that cannot be forgotten. Snow conditions have an important bearing on maintenance costs and this is one problem on which those who are familiar with the locality are better informed than those who are not.

In selecting a route between two control points, the engineer should attempt to locate a highway at the lowest, consistent altitude. The greater the altitude the more frequent and severe are the storms, working conditions are more unfavorable, construction and maintenance costs are higher and snow control is usually more difficult. Winters are longer, snow is deeper, drifting is more prevalent and men and equipment are less efficient.

Air Currents Should Be Studied.—One thing that should not be overlooked is a study of air currents. While prevailing winds are usually known, local conditions can modify this and costly mistakes may be made. A locality where the prevailing wind is a generally ascending rather than a descending one, is usually subject to a much heavier snow fall than where the opposite is true.

Before the advent of aviation little thought was given to up or down drafts and air was assumed to travel in a more or less level plane. Even after this information became available it was not used with the idea of locating a road so as to use these drafts to advantage. We still worked on the old assumptions and when we had the choice of locating on the windward or leeward side of a hill we usually chose the former. Under these conditions it was often observed that after construction there was trouble due to snow lodging on some of the most exposed places. After a while we began to realize that if a snow laden wind is following the surface on an upgrade and then comes to a flat section of roadway, crosses it and again starts on an upgrade, it is probable that this change of direction will cause the air to deposit part of its load of snow. On the other hand if the snow laden air is traveling on a down grade and then comes in contact with a level stretch, there is a likelihood that it will not only retain the snow it is carrying but if any is lying on this section it will probably sweep it off. It is not necessarily true that a down draft exists on the lee side of every hill, because after an air current passes the top of a hill it does not start down for some distance and unless the down slope has some length it will not be subject to down draft.

Natural Protection.—When locating a road it is well to take advantage of all natural protection where this is practicable. The flat, smooth, brushless prairie is usually an inexpensive place to construct a road but it offers no hindrance to the free drifting of snow when the wind starts to blow. Locating through a deep, narrow valley may be less direct, complicate drainage, increase curvature and otherwise be less desirable than some other route. However, snow is usually a lesser hazard in such places than in more open localities. This is a point to be considered in making locations where winters are long and severe. Timber, deep washes, and sharp ledges act as snow traps and will afford protection if the road is properly located.

Winter Surveys.—The location of practically all the roads with which I have been connected during construction has been done during the winter months. Surveys made during the winter are somewhat more expensive than those made at other times of the year but this is a season when our engineering parties are not very busy and it does give the locating engineer a much better opportunity to study drift conditions.

Location and Design.—After a road is properly located, care must be taken in construction design. If alignment, grade or distance were of little importance it would be possible to construct a road that would give little trouble with snow and at a reasonable cost. We could skip from one hogback to another and thereby avoid expensive fills. If we could disregard costs we might construct fills high enough to get grade between points. We have snow with us about five months out of the year, but we expect to use our roads twelve months.

While cuts should be avoided wherever practicable, it is possible to build them in such a way that they need give little trouble. When they are parallel with the prevailing wind they will usually clean themselves. When they are not parallel to the prevailing wind, we excavate one hundred feet in width and to a depth of eighteen inches below grade on each side of roadway. In general design we carry our grade about eighteen inches above the adjacent ground line and keep our borrow pits

A Fence-Protected Road During a Storm

wide and shallow. If headwalls are used on culverts they should be kept below grade, otherwise they are a hindrance to snow removal as well as to other maintenance.

Snow Fences and Other Barriers.—As we all know, drifting snow will lodge at any point where the wind that is carrying it begins to lose velocity. If this happens to be a place on the road, that section of highway is of little use during winter months in locations where snow is prevalent unless some means is taken either to relieve the wind of its burden of snow or else to divert the air current so that it will cross at a point where there is nothing to hinder its free flow.

The favorite means of accomplishing this result is by the use of snow fences although groves of trees and brush are now being used to advantage in many places. Several types of fence are in use. Choice of type depends on angle of prevailing wind with road, on drifting area that is to be protected, on nature of air currents (up or down drafts) and on distance from nearest supply base.

There is the railroad type which is used when it can be left permanently in place. This is used where there is a large drifting area to be protected and where the conditions are such that it is necessary to store rather than divert the drifting snow. We also have the picket type which can be used under similar conditions but it does not have as much storage capacity and is short lived. Preferably this is used where it is necessary to remove and reset the fence each year.

We also have what is known as the deflectng type of snow fence. It is used where the road runs at an angle of twenty to seventy degrees with the wind. It is built on posts that are set permanently and is boarded so that snow will not go through and stop but will follow the fence to a place where there is ample natural storage or an opportunity for it to cross the road without lodging.

Fences Erected on Top of Drifts.—Along the Continental Divide in Wyoming we often have a condition that causes snow to drift almost continually for weeks. A permanent fence will soon fill and become useless. However, it would be possible to build enough fence to hold the snow but it is expensive both to build and maintain. Our method is to use temporary fence to supplement the permanent type. For this purpose we use a sectional fence made of four or five, one inch by six inch boards fourteen feet long. These one by six boards are nailed on two inch by six inch legs, five feet long and are spaced about four inches. Two feet of the two inch by six inch posts are left without any boards nailed on them and act as legs. After the permanent fence fills, these sections are set in the top of the drifts. This provides additional three feet of fence to fill. These are raised as often as is necessary. We often have drifts twenty feet deep which have been formed in this manner.

Often we have freak storms and drifts will form on some of our best constructed roads. There is no way of foreseeing this and providing protection in advance. It may be that it can be cleaned off and the highway will remain clear. Or the drifts may be so extensive that it will be necessary to erect fences to keep the road open. Under these conditions it is not advisable to set permanent fence because this is not only difficult but the chances are that it will not be needed here again. Our method is to use sectional fence. This is set upside down until drifts form, then the fence is turned and legs are placed in the drifts. We continue this procedure until drifting stops.

Snow Removal.—Seven years ago I thought I knew about all there was to know about snow removal, five years ago I thought I knew quite a bit about snow removal, three years ago I thought I knew something about snow removal but now I wonder if I know anything about it. What was the last word in methods and equipment seven years ago is now obsolete and that which was considered good practice in 1929 is now out of date. In 1926 snow removal equipment would cover the road about four miles per hour under forced draft and ten miles of road was about all one unit could keep open under the most favorable circumstances. This type cost from twenty-five to thirty-five dollars per day to operate Some of the equipment we use today will keep forty to fifty miles open under normal storm conditions at a cost of about fifteen dollars per day.

The Beginnings of Snow Removal in Wyoming.—Previous to 1925, Wyoming made little if any effort to remove snow from its highways. The cost made it impracticable for the number of cars which were using our roads during the winter and in most parts of the state the wind would remove most of it from the exposed places within a few days. By using care, those who were familiar with the state could usually get about with no great difficulty. Furthermore every dollar which

The Same Road After the Storm

was used for snow removal meant one dollar less for highway construction. Most of the citizens of Wyoming put their cars away after the first bad storm in the fall and left them there until the roads dried up in the spring.

About this time people began to realize how much they had invested in highways, and they began to insist on the opportunity of using their highways twelve months per year. There was no point in highway officials trying to persuade them that it was impracticable to keep the roads open because these officials were informed that if they could not find a way to do it, said citizens would find someone that could.

The little old country school house may have been good enough for our fathers and us but our children must have improved school facilities and this meant open roads during the winter so that the school bus could take the country children to the town school.

Interstate Traffic Becomes a Factor.—About this time interstate traffic became a twelve-month problem. Eastern people had to go to California for winter golf and of necessity had to take their cars along. Citizens of the Pacific Coast had to go east for various reasons and they likewise had to have their cars with them regardless of the season. If the state they came from ever had had any snow it was almost impossible to get them to admit that snow had ever given them any trouble until they crossed the Wyoming line. They could look at their road map and it showed the Lincoln Highway running right through Southern Wyoming at a latitude of about forty degrees which is about the same as Northern California. The fact that this road crosses a region at an altitude varying from six to nine thousand feet above sea level, gave them little concern.

At this time the Lincoln Highway in Wyoming was graded after a fashion but it was not in shape to make snow removal practicable. We had no snow fence to protect our weak places and had little knowledge of drift control. However, these winter motorists insisted on attempting to use our highways and it was no uncommon thing for cars to be stranded many miles from the nearest habitation. Intense suffering and loss of life was the result. We began sending patrols over our roads to help stranded cars. We built and maintained shelter camps at different points and kept them supplied with fuel and food but the winter toll grew larger every winter and through traffic continued to increase. The popular demand for snow removal became more and more insistent and in compliance with this demand we started our first snow removal program in December, 1925.

About the only experience most of us had had with snow removal previous to this time was with a scoop shovel. While this method is fairly well suited to getting a car out of a snow drift it is not adapted to a large scale program.

The first equipment we used was a tractor and grader and we did not do badly with the first storm because the wind had it pretty well cleared up before we got very far.

Windrows Make Unforeseen Trouble.—On December 13th a northeaster started and last for two days. Unfortunately the wind did not blow for about a day after the storm cleared up and we had time to get out and pile up the snow in windrows on each side of the road. Then the wind started and snow traveled until it came to our windrows and there it stopped until the space between the windrows was filled. We did our best to raise these wind breaks with the result that by the first of the year the only way that one could get a car out of either Rawlins or Laramie was by rail.

Sectional Fence Saved Bad Drifts Here

After our highways were buried under so much snow that it was impossible to get even a tractor through, we bladed detours and when these became impassable we bladed new ones. We kept this up until spring then we plowed the snow and ice off the roads and after they had dried out somewhat we opened them up for traffic again.

That was the only time I tried that system. The next fall we placed snow fence to protect the places that gave us the most trouble the winter before. We still used the same tractor and blade for removing snow but we did not leave the windrows alongside the road. It might take us all day to get one drift back far enough to prevent it from forming again but we did not leave it until there was no danger of this happening. This type of snow removal was not an unqualified success and it was expensive but far more successful than the plan which had been used the year before.

Organization and Procedure.—Each year we improve our methods and add to and get better equipment. Our roads are now in better shape for this class of work. We likewise have a more perfected organization and more experienced supervision.

In order to get proper supervision, my district is divided into three sections for snow operations. I take charge of the western section, using Rawlins as a base. One of our crew foremen has charge of the central section, using Medicine Bow as a base and the maintenance foreman takes charge of the eastern section using Laramie as a base.

At each base there is a stock of temporary snow fence ready to be sent out as soon as the necessity arises. We also have a light truck and an extra gang ready to go out and set up fence ahead of any major drift removal. There is also light and heavy truck equipment as well as tractors, blades and bulldozers.

When the men used for snow removal are not busy with snow, they are engaged in hauling gravel for surface maintenance, repairing bridges, seeing that equipment is ready to go or doing the many other things that always require attention. Except during a storm, the maintenance foreman has direct charge of his regular work but when a severe storm starts we drop everything, go to our stations and stay there until all danger is past. When one gets his section in shape he goes to the assistance of the others.

Seven Cardinal Rules and the Reasons for Them.—We have seven rules that we insist on being observed by those engaged in snow removal. The first is: "Clean roads at earliest opportunity." When snow first falls it is usually light and easily removed, while if allowed to lie it soon becomes packed and frozen and requires heavy equipment and extra labor. Traffic also tends to collect snow on a roadway if it is not clean.

Anything under six inches of light, dry snow can be cleaned with a light truck equipped with a six-foot V-

plow or snow drag, at a cost of about fifty cents per mile. If allowed to pack, freeze and start drifting, this same snow will require heavy truck and plow equipment and will cost from three to ten dollars per mile. If allowed to get to the blockade stage it will require tractor and heavy equipment and costs will run from fifty to three hundred dollars per mile. The more snow there is the more pains must be taken in disposing of it. While one round trip will dispose of loose light snow it takes several to get drifts back where they will not cause further trouble.

The second rule is: "Leave no snow ridges above level of roadway." In my district, there are about twenty miles of highway below sixty-five hundred feet, one hundred and ninety-two miles between sixty-five hundred and seven thousand feet, two hundred and forty miles between seven and nine thousand feet and about ten miles above nine thousand feet. At this altitude there is little if any thawing between November first and April first. The only way nature assists in disposing of snow at this altitude is by blowing it in piles behind hills or by dumping it into depressions. If we should stack the snow up on each side of the road we would make a depression of the middle of the road and nature would spend the balance of the winter filling it in faster than we could take it out.

The next rule is: "Don't use light equipment for drift removal." Light equipment cannot be beat for moving light loose snow but it will not stand up in drifts. Heavy trucks and plows are satisfactory if drifts are not too deep or compacted. Only careful, experienced men should be used in this class of work. Where drifts are deep, and hard, only tractors, heavy blades, and bulldozers should be used.

Rule four is: "Don't open drift a second time until protection is provided." Usually if a drift is properly cleaned it will stay open until another major storm comes. If it should persist in forming it is useless to open it until snow fence is set or some other means of protection has been provided. Each time a drift is opened it is harder than the previous time and the tendency to form again is greater than before.

Rule five is: "Use only experienced men on snow equipment." One inexperienced man can tie up more road than ten men can open. He can also break more equipment than a shop force can keep in repair.

Rule six is: "Always work from base and clean as you go." Fighting snow is like any other war: You must keep the line of communications open. It is much easier and faster to move men, supplies and equipment over a good road than over a poor one.

The seventh rule is: "Don't rely on road reports given by the public." The average road report is misleading. Most people will get very much concerned about a section of road that is somewhat difficult to drive over but in no danger of blockading. At the same time they will blissfully ignore a section that is passable but in danger of being blocked in a short time. Watch every mile yourself or have someone in whose judgment you have confidence do it for you.

These rules that I have mentioned are all right but they do not take the place of common sense. I do not care how good a man is. He may be the most willing man in the world but if he does not have good judgment he is useless. In snow removal conditions are changing hourly. It is hard to tell always what should be done in advance and when you are working out on two or three fronts you cannot be on all of them at once so it is necessary for each one in charge of a unit to be able to take his share of the responsibility.

Men of this type are hard to find and usually when we have serious blockades it is due to lack of men qualified to handle this work.

The old proverb, "an ounce of prevention is worth a pound of cure," applies most forcibly to snow control.

Acknowledgment.—The foregoing is a paper presented at the 1934 Highway Conference, University of Colorado.

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Tests on Friction Coefficient of Pavements

By R. W. CRUM

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The many roadside signs that warn the traveler "Road Slippery When Wet" are a constant challenge to road builders to produce surfaces that will resist skidding under unfavorable conditions. One of the reasons why this problem has not been entirely solved has been the lack of a method of testing road surfaces to determine the degree of their resistance to skidding.

The solution of this problem took a long step ahead when at a recent meeting of the Highway Research Board of the National Research Council, two independent investigators reported tests with machines devised to measure the coefficient of friction between tires and road surfaces at all speeds. The instruments although radically different in design both consisted of trailers on which the brakes could be set at any instant and the resistance to rolling or sliding could be measured and recorded.

Professor R. A. Moyer of Iowa State College measured the coefficients of friction upon 25 different surfaces in Iowa, Indiana and Ohio at various speeds up to 40 miles per hour.

Professors Stinson and Roberts of Ohio State University made similar tests on nine roads in Ohio at speeds up to 50 miles per hour.

Some very significant facts were determined that should have great influence, not only upon road construction practices, but upon driving habits as well. For instance, it is important for drivers to know that as their speed increases the resistance to sliding decreases, and that as shown in the Ohio tests "the driving hazards on wet roads become much more serious as the speed is increased, not only because of the decrease in the rolling as well as sliding coefficients of friction, but also on account of the increasing difference between the values of the rolling and sliding coefficients." This latter variation is exceedingly serious when brakes are applied suddenly, as any type of brake may operate unequally at times on the four wheels and when one wheel slides there is a radical decrease in breaking force on this wheel which may easily cause the driver to lose control of the car.

Of great interest to the road builder was the fact that in the Iowa tests the greatest resistance to skidding was offered by those surfaces which had what may best be described as a "sand paper" finish.

Effect of Chains on Ice.—Drivers will be interested to know that the tests on sleet and ice covered surfaces indicated that although the ordinary tire chains with cross chains about six inches apart increased traction for driving straight ahead, little protection against skidding sideways was provided. However, chains having cross chains about three inches apart gave considerably greater resistance to skidding as in this case there are two cross chains bearing the weight of the car practically all of the time which causes the chains to cut into the ice and thus increase the friction.

BITUMINOUS MAT SURFACES FOR CITY STREETS

By C. H. BRYSON
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DURING the 1933 season, there was laid on the streets of Colorado Springs a total of 317,364 sq. yd. of bituminous mat surfacing 1 in. in thickness. This amounted to 11.2 miles of streets having widths from 30 ft. to 70 ft. and averaging 53.6 ft. in width. The only previous surfacing of this type was during the fall of 1932 when 20,294 sq. yd. were laid, the first 9,708 sq. yd. of which were put down as an experiment to see if the excellent results obtained by the highway department of the city of Denver with this type of surfacing could be duplicated with our considerably different aggregates. This experimental work was done by the exact city of Denver methods and oil content, and under the supervision of a city of Denver Highway Department foreman. While this experimental work was fairly satisfactory, it was found that with our different foundation or subgrade and different aggregate grading, a much leaner oil content would give more satisfactory results. Furthermore, our much wider streets seemed to indicate that a different method of construction would have to be followed.

Accurate cost records were kept on the 1932 work, and it was decided to compute estimates of cost on the proposed 1933 work at 15 ct. per square yard. As all gravel surfaced streets had been built by the city with no assessment to the abutting property, except for curb and gutter, it was decided to assess each street on a straight front-foot basis to the abutting property; the city, however, paying for the street and alley intersections which, on the 1933 work, amounted to 49,913 sq. yd. of 15.7 per cent of the total yardage laid. The city also purchased all equipment used from general funds raised by taxation.

As an example of the low cost of this work—the total assessment for a 50-ft. lot on a street 50 ft. in width amounted to only $18.75. Requests for the improvement were by petition to the city council and when sufficient of these petitions with a majority of frontage were received by the Council, an improvement district was created. The 1933 work was done under ordinances which created four different improvement districts with a total of 131 blocks of streets.

Foundation or Subgrade.—The natural soil over about two-thirds of the area of the city is adobe, while the remainder is either gravel or sand. In the adobe section, all streets have been and are continually being surfaced with gravel. This gravel surfacing varies from 1 to 6 in. in thickness depending on the importance of the street, and the length of time since it has been graveled. These streets are all hard, compact, and with few exceptions well above the groundwater plane.

Aggregates.—The coarse aggregate or gravel used was hand loaded, and hauled on an average of about 3½ miles. It was a pit run disintegrated granite containing a small amount of oversize material. The following is an average sieve analysis:

	Per Cent
Passing 10 mesh	50-60
Retained 48 mesh	70-75
Passing 48 mesh, retained 100 mesh	12-16
Passing 100 mesh, retained 200 mesh	10-12
Passing 200 mesh	3- 4
Average weight of gravel	93 lb. per cu. ft.

The dust or filler was obtained from pits opened in the mill slime deposits from one of the several gold reduction mills. This material runs about 91 per cent passing a 200-mesh sieve, and while there are hundreds of thousands of tons of this material available, there are only small areas where it can be obtained sufficiently dry to use without running it through a drying plant.

Oil.—The oil used was furnished by the low bidder, The Standard Oil Company of Indiana, and complied with the city of Denver Highway Department specifications which are in brief:

Flash point not less than 200 degrees F. Viscosity, 150-300 seconds. Asphaltic-content, not less than 65 per cent nor more than 75 per cent of asphaltic residue having a penetration of 80 at 77 degrees F. Ductility of the 80 penetration residue at 39.2 degrees F., not less than 5 centimeters; at 77 degrees F., not less than 80 centimeters. Solubility in carbon tetrachloride, not less than 99 per cent.

Method of Construction.—The usual construction procedure was as follows:

Several days (usually a week or more) prior to the date set for commencing the material haul, the street was thoroughly sprinkled and smoothed from gutter to

gutter with a motor grader. All holes were cut out and high places in the crown were cut off and hauled away. Where filling was necessary, the fill was made in small layers and the street allowed to lie for several weeks before any further work was done.

One or two days preceding the date set for beginning the material haul, the street, or if the improvement was more than two blocks in length, two blocks of the street, was sprinkled again by a power sprinkler, and a motor grader was again operated from gutter to gutters cutting from ¼ in. to ½ in. from the old gravel surfacing and increasing this to from 2 to 3 in. immediately adjacent to the concrete gutter. Inasmuch as this cut material was practically the same as the pit gravel, except that it usually contained more or less clay binder, it was left in a windrow in the center of the street and the contents of the windrow accurately measured. On a few blocks of streets, where the gravel surfacing was very thin, or where the subgrade was a hard packed sandy loam, the subgrade was not wet or cut, and only the loose material was windrowed in the center. This light wetting and blading ahead of the aggregate haul accomplished the following: all loose gravel not compacted was put in the windrow; the action of the blade further compacted the subgrade; the aggregate salvaged from the old surfacing greatly lessened the amount of new gravel to be hauled (during the entire season's work, approximately 32 per cent of the coarse aggregate used in the mat was obtained from the old gravel surfacing).

Following the measuring of the windrow of salvaged coarse aggregate, the amount of new gravel necessary to cover the entire street area 1¼ in. deep was computed, and hauled and dumped on the windrow. After the completion of the coarse aggregate haul, a sieve analysis was taken and the deficiency of 200-mesh material to make the 200-mesh content 10 per cent by weight of the total aggregate (dry sieving) computed. This amount was then hauled in from the mill dump and placed on the windrow.

The fine and coarse aggregate was mixed dry in the center of the street and again windrowed. A sieve analysis of the mixture was then taken from which the oil content was computed.

The street on both sides of the windrow of aggregate was swept with a revolving broom which was attached to the front of a 1½ ton truck.

A tack coat of 0.25 gal. of hot oil (175°-225° F.) was applied to the swept portion of the street following which the windrow of aggregate was moved from the center of the street by the motor graders to cover the tack coat.

The final application of oil as computed from the aggregate sieve analysis by the New Mexico State Highway Department and the Wyoming State Highway Department formulae was then applied on top of the spread aggregate and on the center section which had been occupied by the windrow. As this section had received no tack coat, 0.25 gal. additional was applied. Processing by the motor graders was commenced immediately and continued until the whole mass was of uniform color. The processed material was then spread in light layers. When spreading was completed, a light windrow was left in one gutter to fill ruts during blading with a light motor grader on the following two days. Traffic was not barred from the street except while the oil was being applied.

A typical sieve analysis of the dry mixed aggregate was as follows:

	Per Cent
Passing 10 mesh	60
Retained 48 mesh	70
Passing 48 mesh, retained 100 mesh	12
Passing 100 mesh, retained 200 mesh	9
Passing 200 mesh	9

According to the New Mexico formula, the oil content is 5.39 per cent, and by the Wyoming formula, 5.10 per cent.

Compaction.—No roller of any kind was used on the work, the entire compaction being done by motor graders, distributor, and by traffic. During the first part of the work, the area adjacent to the gutters was compacted by running the loaded distributor back and forth along the gutters, but during the latter part of the season, the compaction of the entire street was done by traffic. The gutters were compacted by barricading the entire center portion of the street and forcing traffic to use the edge for several days. Then the edges were barricaded and traffic was forced to use the center strip.

Progress.—Work was commenced on June 12 and completed on October 7. Progress by months was as follows:

	Sq. Yd.
June	73,204
July	123,785
August	69,673
September	41,125
October	4,677

The total amount of oil was 273,000 gal. or 0.86 gal. per square yard. Gravel hauled for the work totaled 7,201 cu. yd. and 928 cu. yd. of the dust were used.

Equipment.—The following equipment was used on the work:

One Municipal Supply Co. Model 200—1,000 gallon capacity distributor.

Two Austin, Model 77, pneumatic tired motor graders with 10 foot blade and oil mix moldboard.

One Galion 10-20 pneumatic tired motor grader with 10 foot blade.

One Fordson Wehr pneumatic tired motor grader with 8 foot blade.

One Willett revolving broom attached to a one and one-half ton truck.

One Caterpillar 65 tractor with pavement plates pulling a pneumatic tired Galion grader with 10-foot blade. (This equipment was used part time only.)

Five to eight 1½ ton dump trucks.

As this equipment was bought and maintained by the City Street Department, the following charges to the improvement districts were made for the use of the equipment per hour:

Austin Motor Grader	$1.75
Distributor	2.25
Galion Motor Grader	1.25
Fordson Motor Grader	1.00
Tractor and grader	2.75
1½ ton dump trucks	.50

The above charges do not include operators whose time was charged directly to the improvement districts.

Conclusion.—The 1-in. bituminous mat surfacing which has been laid on our streets during the past year and a half has been entirely satisfactory both from the city's and from the property owner's standpoint. Its low cost, freedom from dust, smooth riding surface under all weather conditions, and its ability to carry large storm water flows without scouring as gravel surfaced streets do, has merited almost 100 per cent abutting property owner approval. This is strikingly evidenced by the fact that 65 per cent of all assessments were paid in cash within 30 days from the time notices were sent out. From the city's standpoint, the maintenance to date has been much lower than that on our gravel surfaced streets.

Acknowledgment.—The following is a paper presented at the 1934 Highway Convention at the University of Colorado.

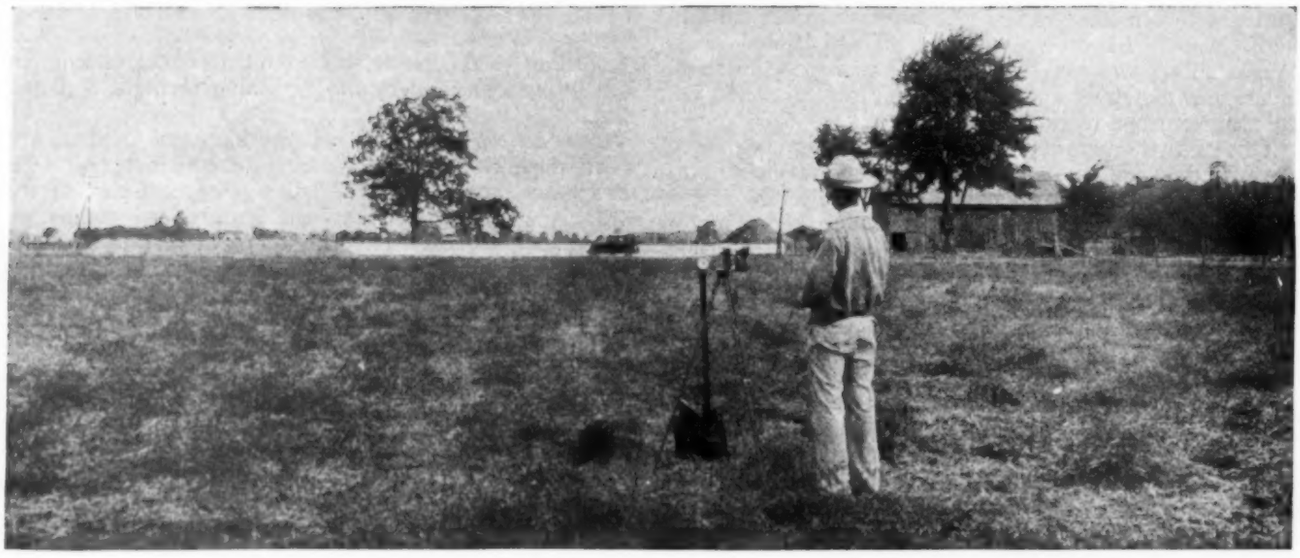

Fig. 2—The Outfit in Service

A MOVIE CAMERA IN TRAFFIC STUDY

By
BRUCE D. GREENSHIELDS,
Prof. of Engineering Sciences, Dennison University, Granville, Ohio
and
ROY S. SWINTON,
Assoc. Prof. of Engineering Mechanics, University of Michigan, Ann Arbor

THIS report takes up the methods used in making a study of the speed and spacing of vehicles and the resultant traffic capacity of various types of roadway as reported in *A Comparative Study of Traffic Behavior Upon Gravel Roads Stabilized with Calcium-Chloride and Natural Soil Binder and Other Types of Roadway Surfaces* to be published in a later issue of ROADS AND STREETS. Some 30,000 pictures of Michigan roads were taken and analyzed during the summer of 1933. Now the method has been introduced by the traffic engineers of the Ohio State Highway Department and results are awaited with interest.

Methods of Securing and Analyzing Data.—By taking pictures of the vehicular traffic at short, definite intervals of time an instantaneous record of the position of the vehicles at the end of each interval can be obtained. From the position of a vehicle in each of two successive pictures its velocity is found and its rate of acceleration or deceleration determined from three or more pictures. The space between vehicles, when they appear in the same picture, is evident. In case the following vehicle does not appear in the next succeeding picture, but in one at a later interval, the spacing may be determined with a fair degree of accuracy from the velocities of the cars and the interval elapsing between the pictures in which they appear.

The field method of securing the desired data was quite simple. Pictures were taken by a 16-m.m. Simplex movie camera, capable of what is known as stop motion, or the snapping of individual pictures. An electric motor driven by an automobile storage battery operated the device with a uniform time interval between exposures. Fig. 1 shows the head of the instrument, and Fig. 2 shows the whole set-up, including the storage cells.

The time interval was adjusted to a selected value

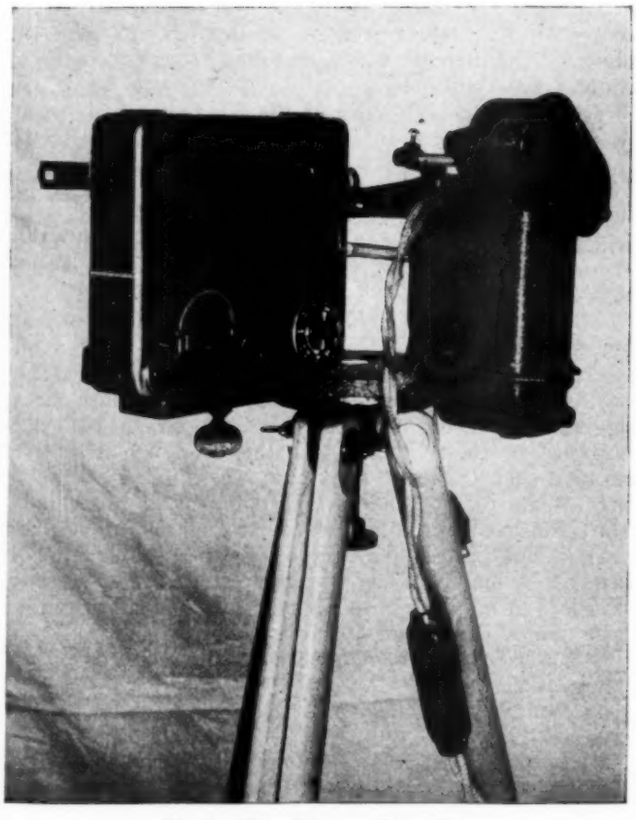

Fig. 1—The Camera Assembly

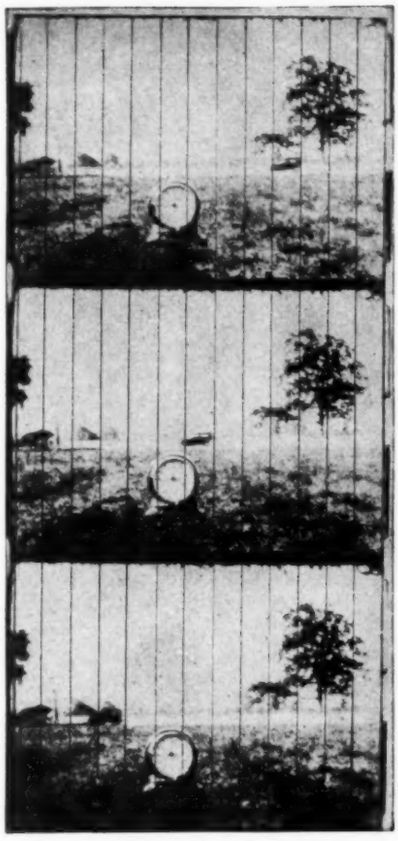

Fig. 3—Pictures Ready for Study

between one-half and two seconds. Varying the voltage by changing the battery terminals has been found more reliable than rheostat control. The time interval was observed carefully with a stop watch for a period of 40 to 100 exposures and checked by the sweep hand of the photographic timer included in the pictures. For moving cars a field of twice the space traveled per time interval is necessary to insure two pictures of each car. Elimination of photographic blue due to the motion of a car across the picture required that the highway be at least 300 feet from the camera. This made the length of road studied about 125 feet. At the beginning of each film, and hourly during a run, there was included a photograph of a bulletin board giving the location, date, hour, time interval, shutter opening, and other pertinent information.

The measured distance from the camera to the road, together with the camera characteristics sufficed to give the scale of dimensions. However, a complete plan of the section of the roadway studied was recorded which gave distances from the camera and between objects in the pictures, such as posts or poles to be used as a check of the scale. Where no identifications existed, a 100-foot tape was laid along the pavement and at every 10-foot interval a target was held over the point and photographed. This gave a definite scale for the picture.

Method of Analysis.—The process of analysis consists of two parts: the pictures are first projected upon a white screen ruled with parallel markings and the throw of the lantern is so adjusted that these divisions represent five- or ten-foot intervals along the roadway in the picture; and second, the distance of travel or speed and the spacing between cars is taken off from two pictures projected upon the screen at the same time. To obtain a traffic flow curve for the highway, the time may be read from the timer as photographed.

The method of studying the pictures may be illustrated from Fig. 3. In the first picture at the top, the car is at point 40 of the scale. In the second picture .682 seconds later, it has advanced to point 71 on the scale. Reduced to miles per hour this is 31.0. It should be noted that if this time interval is used the distance traveled in feet equals the speed in miles per hour to the nearest tenth. By reading this scale in the third picture it is found that the speed of the car is practically uniform, so that there is no acceleration. To facilitate reading in case accelerations are not wanted, the projection lantern may be mounted on a thin board secured in place by a center pin so that the board and projector may be easily rotated to bring the first car to zero on the scale and thus the position or station need not be used, the distance moved or speed being read instead. Fig. 4 shows such a data sheet.

A Study of Congestion.—The speed of all vehicles with a spacing of over 125 feet will, on firm dustless surfaces, give the normal speed of the vehicles for any particular highway, provided large enough numbers are observed to insure a fair average. The difference between the average normal rate of speed so obtained and the average rate at which all traffic is moving will give the delay or loss in speed due to congestion. Recently in Ohio it has been found that both the average and maximum speeds decrease during congestion so that uncongested speeds should be found from light traffic hours.

The results of observations made on Route U. S. 112, a few miles west of Ypsilanti, Michigan, on August 27, 1933, are tabulated for the sake of clearness. (See Table I.)

TABLE I.—LOSS OF SPEED DUE TO CONGESTION

West Bound Traffic on Route U. S. 112 Near Ypsilanti, Michigan, August 27, 1933

Time of Observation Hr.	Min.	Sec.	West Bound Pass. Cars	Av. Speed	W. B. Trucks	Av. Speed	Free Pass Car Speed	Total W. B. Traffic per Hr.	Av. Speed Loss in m.p.h. per Vehicle	
11	28	29								
to										
11	44	50	32	48.2	3	46.5	25 free cars at 50.6	131	2.4	(East bound)
1	50	30								
to										
2	12	43	90	39.4	4	34.2	44 free cars at 41.7	243	2.3	(West bound)
2	12	43								
to										
2	36	56	100	41.8	2	33.6	66 free cars at 43.0	248	1.2	(West bound)
2	40	14								
to										
2	53	15	29	45.0	1	39.6	22 free cars at 47.0	138	2.0	(East bound)
4	52	45								
to										
5	17	37	140	42.2	4	40.1	85 free cars at 45.0	338	2.1	(East bound)

The elements of uncertainty have been largely eliminated in application of the process used in these studies by comparison of group averages as found with different camera operating speeds, and comparison of similar traffic situations. A further interesting phenomenon appears when it is found that a group of several hundred cars range in speed from 15 to 70 miles per hour. If the percentage of cars included below each speed in this range is plotted, they may be expected to form a summation of the normal probability curve. To simplify the study of such data, use is made of a special co-ordinate paper on which a normal probability forms a straight line. The main center range is used to establish the law. The curve shown on Fig. 5 was plotted for 125 cars ranging through the speeds shown. For such a condition one may expect only 2 per cent of the drivers to exceed 65 miles per hour and 10 per cent to travel at less than 17 miles per hour. From studies it appears that total economy attained through excessive speeds is very slight. Such curves are never straight near the ends which involve so few cases, but any irregularity within the curve indicates an error or a change in human behavior for which there must be a reason. In this study approximately 30,000 pictures were reviewed with perhaps six pictures for each car. Analysis was made of groups taken at various camera speeds, similar groups taken on different days, and in different locations. It is believed that the process is reliable and has potential value in several fields even outside those of traffic control and the road builder. The pictures reflect the economic wealth and interests of the communities served by the traffic lanes.

Film Record. Job # 856 Sheet No. 1 Going W

Location, Highway or St. U.S. 112 concrete

2 Mi. from Saline. Our designation, Sta. _____

Film (V)(S)___, Camera #1 Log Sheet by R.S.S.

Date Aug.27,1933. ReStudy X reference _____

Analysis by E.G.. Check by _____, 9/9/1933 MB _____

Pic./ Min.	Time M	Sec.	Interval	Velocity Mi./hr.	Dist. Trav.	Spacing	Type Car
71/min. 1.33 = const.	28	22		49	37		C
	28	40	18	53	40	965	C
	29	03	23	47	35	1070	C
	29	10	7	40	30	279	C
	29	20	10	41	31	412	C
	29	25	5	43	32	219	C
	29	34	9	45	34	407	C
	29	40	6	50	38	303	C
	29	46	6	48	36	287	C
	29	49	3	50	38	151	C
	30	02	13	44	33	565	C
				41	31	50	C
70/min. 1.31 = const.	30	06		45	34	37	C
	30	27	21	35	26	778	C
		38	11	60	45	610	C
		40	2	37	28	73	C
		41		44	33	40	C
	31	03	23	43	32	920	C
	32	20	77	35	26	2620	C
		25	5	37	28	163	C
		27		48	36	42	C
		48	21	29	22	588	C
		59	11	52	39	563	C
		59		60	38	55	C
	33	11	14	49	37	625	C
		36	25	60	45	1475	C
		46	10	48	36	472	C
	34	01	15	40	30	590	C
		02		47	35	35	C
		14	13	36	27	425	C

Fig. 4—A Typical Data Sheet

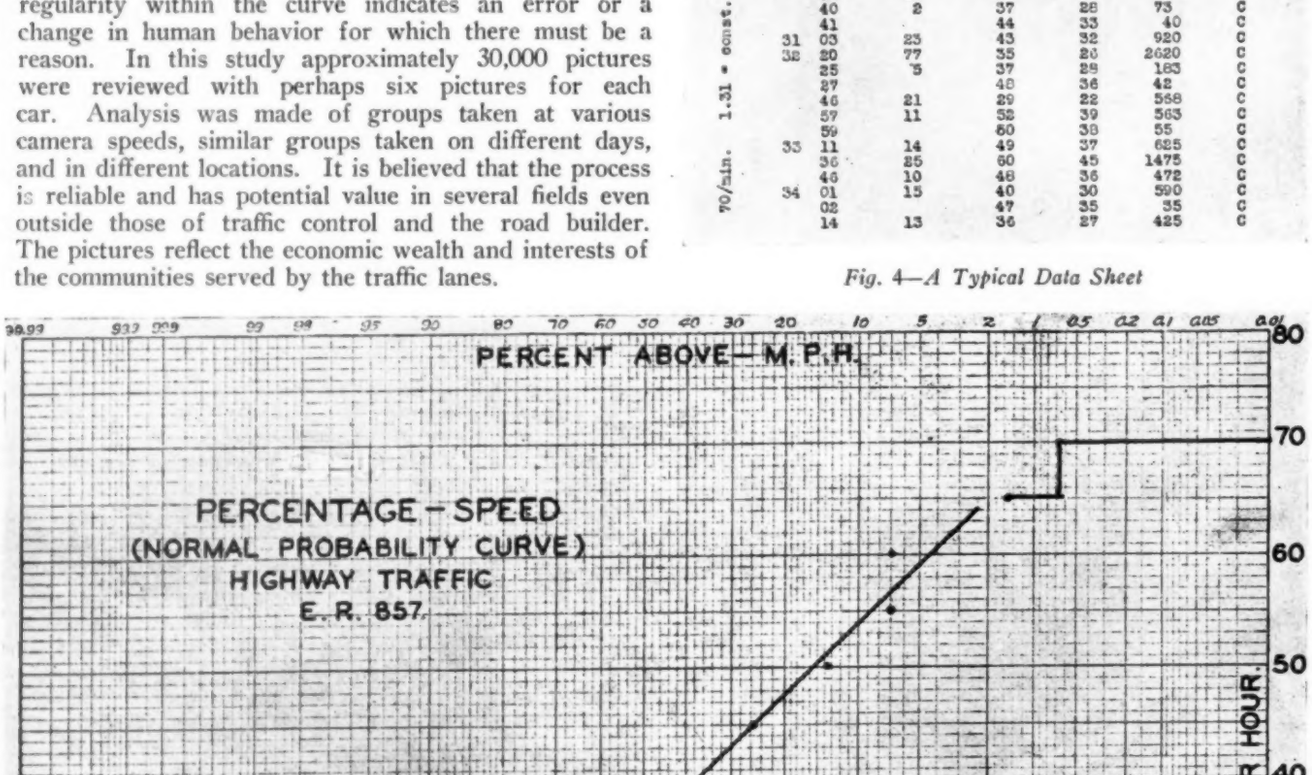

Fig. 5—Curve Showing Probable Percentages of Cars Traveling Above and Below Any Given Speed. Based on 125 Observations.

HIGHWAY ROUTES THROUGH CITIES
The Need and Opportunity for Improving Pavements

By JOHN W. WHEELER

Member, Indiana State Highway Commission, Indianapolis

IN the conception of the law creating a state highway commission, we had in mind expediting travel between centers of population, such as county seats and neighboring cities of the larger class. We wanted to go, for instance, from Logansport to Delphi. We did not see that in these short fifteen years our highway system would become the main transportation system of Indiana, and, linked up with similar roads in other states, would provide the principal transportation system of the nation.

Early Legal Restriction.—A few years ago when we in Lake County wanted to come to Indianapolis, we boarded a train to make the trip. Of late, however, we think only of driving, and after riding along over smooth pavement for miles and miles, we wonder why we should bump through Lebanon. The original law did not permit the state highway commission to make improvements in cities of over 2,500 population. Later this was raised to 3,500. Last year, when the law was again rewritten and enacted, it was considered making it possible to go through all cities on state highway routes, but because the special session of the 1932 legislature had taken half of the money from the highway commission, it was felt that the commission should not take over additional mileage with this handicap. So, as far as the statute of the state is concerned, the commission is unable to make improvements in cities of over 3,500 population.

Opportunities Under the Reconstruction Act.—With the enactment of the National Reconstruction Act, $400,000,000 was set aside and given to the Bureau of Public Roads to be spent by the state highway commissions, as its agents, under the following regulations: At least 25 per cent had to be spent on the federal system of highway routes outside of the cities. At least 25 per cent had to be spent on the routes of state highways through the cities and on the federal system. As much as 25 per cent could be spent on feeder roads, which did not necessarily have to be on either the federal or the state system.

We saw an opportunity here to do something for the cities which all along had received the small end of the benefits of the state highway commission. Instead of stopping at the minimum of 25 per cent, we chose to spend 48 per cent, totaling in round numbers $4,800,000 in the cities. Since there was no provision in the statute for going into cities, you can readily realize that we were handicapped in not having one scratch of a pen in the shape of surveys or plans for city work. We chose to go into 60 cities with 140 projects, each necessitating surveys, plans, and estimates. This has taken time and we have been roundly criticised by the authorities in Washington for being slow; however, we feel that our decision was just, and that much more benefit will come from the money expended by following the method that we have chosen.

Lack of Surveys a Handicap.—When this federal law, which permitted us to go into the cities, was enacted, a hurried survey was made by the commissioners themselves, accompanied by their engineers, and the above number of projects was selected as being the most worthy. We endeavored to divide up the benefits among as many cities as possible and to cover the state as evenly as possible geographically. After conferring with the Bureau of Public Roads, we decided that city streets on the federal routes, which apparently had a good base under them, should be resurfaced, and that those which did not have a good base under them should be torn out and reconstructed with modern pavement. If the curb was inadequate or badly broken, we decided to build new curb.

Street Railway Difficulties.—As these survey notes came in from the various city projects, our troubles began to multiply. The greatest obstacle that the state highway commission encountered in trying to improve city streets was the existence of city street railways. We told the railway companies that, if they would rehabilitate their tracks and properties, we were confident that the Bureau of Public Roads would be willing that we pave the surface. In practically every case, the railway company plead no funds, so that part of the project was thereby halted. It will be very difficult for the state highway commission to turn out good paving or resurfacing work within the cities where street railway properties cannot be rehabilitated at this time. We will merely have to make our improvement up to the end of the tie and leave the dilapidated street railway in its present condition. This will have, as you can readily realize, a very sad effect on the appearance of the work that we plan to do.

Another great difficulty is to devise a proper resurface material which can be applied thin enough to resurface an old brick street, for instance, and join up with a street car track. We will take the case of a street car track that is in operation, and in so far as the railway is concerned, is satisfactory. The top of the rail is now approximately level with the top of the old worn brick pavement that joins it. How to put a proper resurface on this brick pavement, and still meet the top of the rail, is a problem causing us a great deal of trouble. If we feather-edge the resurface material, it will break away in the thinner section and leave a bad appearance. If we raise the brick header from the rail over to the end of the tie so that it will be possible to put a two-inch resurface up against this header, we have then depressed our railway track below the surface of the new pavement and formed a gutter in the middle

of the street, down which water will have to run to an intersection, or perhaps until the street railway turns and allows the water to follow the rail on to a side street. Either one of these methods will prove unsatisfactory. Where the street railway is in a position to raise its tracks the needed amount, the whole program will be materially helped.

Storm Sewers Required in Some Cases.—In other cases, we find projects where it will be necessary to construct storm sewers so that our new street or our resurfaced street can be drained. This runs into big money. Every time that we have to build one of these sewers out of the estimate that we had originally made for the street, it is bound to shorten the pavement project. We must remember then that when this $4,800,000 is gone, there is no way to add to it under our statute, and unless the Bureau of Public Roads grants more money for city improvement, this improvement will have to be final until such time as our legislature puts the state highway routes through the cities into the state highway system.

Pavement Types.—We might discuss what kind of streets and what kind of resurfacing the cities will probably receive. As I mentioned before, wherever the base is adequate but the surface is rough, resurface has been recommended. An average thickness would be 2½ inches. This will probably consist of hot or cold binder with a wearing surface of either hot- or cold-mix asphalt or rock asphalt. A great drive has been made by the patented pavement manufacturers, and under the federal regulations, I believe, it is possible to specify patented pavements under their trade names as alternates to the above-mentioned resurfacing materials. This may or may not be done, depending on the decision of the highway commission. Where a project for new construction is endorsed by the Bureau of Public Roads, it will probably be built out of concrete, because all of these projects are on state highway routes through cities where the amount of traffic is heavy; and from our experience over a term of years, when alternate types of new pavement are called for, we have found cement concrete pavement to be the lowest priced. This price might, however, change to such an extent that some other material would be low.

Just a Beginning.—We now find that the $4,800,000 that we have allotted to city projects will only scratch the surface of the needed street improvements on the routes of the federal system through the cities of Indiana. But with this start, we wish to give the people an example of the kind of work the state highway commission could build in the cities if these city streets were a part of the highway system. We hope that the nature of our work will be such as to invite a sound discussion as to whether or not the next session of the legislature should or should not take these city routes into the state highway system.

Allocation of Motor Vehicle Revenues.—Prior to the special session of 1932, the state highway commission received 75 per cent of the revenue from the gas tax, and all of the motor vehicle tax. At that session, half of the total gas tax and half of the total motor vehicle tax were allotted to the counties, cities, and towns. When a revenue is cut directly in two, any executive must become at least mildly apprehensive of taking on additional expense, and that is the reason that the law enacted at the regular session of the 1933 legislature did not place the city streets in the state highway system.

The question that confronts us now is: "Who is to carry on and finish the highway system?" If it be the counties, cities, and towns, all well and good, and the division should remain as it is; but if the people feel that the state highway commission should improve and maintain these routes through the cities, then it will be necessary that part of this money, at least, be returned to the highway commission. As revenues now stand, the highway commission can construct a limited mileage each year in filling gaps, widening existing pavements that are overloaded, and maintaining the entire system in as good or better condition than ever before. But that is all, and if more mileage outside the cities and the routes of state highways through the cities should be added, additional revenue must come to the highway commission.

I wish to quote a recent editorial, written by Professor Ben H. Petty, expressing his opinion of the future development of Indiana highways. The article reads as follows:

"Future of Roads in Indiana?—The Editor believes it would be good policy for the State Highway Commission to double or treble its present road mileage within the next ten years, arriving at a maximum of about 25,000 miles. This could be done at the rate of, say, 1,500 miles per year with a proportionate additional allocation of gasoline tax and license fees to the State Highway Commission for the necessary improvement and maintenance of this mileage. This *gradual* absorption of the more heavily traveled county roads, on which much of the county maintenance money is expended, would not interfere with the efficient functioning of the State Highway Commission. We believe that all roads in the state of Indiana, on which traffic justifies a surface better than an ordinary untreated gravel or stone surface, belong in the state highway system. The remaining 52,000 miles of county roads would be largely local farm roads and should be maintained by county road authorities."

These last two suggestions that I have placed before you—namely, the inclusion of the city streets in the state highway system, and Professor Petty's viewpoints on enlarging the state highway system—are purely matters for the electorate of Indiana to decide, and I leave them with you for discussion.

Acknowledgment.—The foregoing is a slight condensation of a paper presented at the 20th Annual Road School at Purdue University.

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Sodium-Vapor Highway Lighting Now Installed in New York Metropolitan Area

Twelve units of G-E sodium-vapor lamps, each rated at 10,000 lumens, were recently placed in service on Jerome Ave., between 233rd St. and Yonkers, in the Metropolitan area of New York. The installation is the first highway application of such lamps in the vicinity of the metropolis.

The twelve units are mounted at a height of 25 feet and are spaced an average of 227 feet apart in a staggered arrangement. When the lamps were first turned on, the installation was inspected by Maurice P. Davidson, Commissioner of the Department of Water Supply, Gas and Electricity, of New York. He was accompanied by other city officials and by representatives of the New York Edison Company and of the General Electric Company, manufacturers of the lighting units.

This type of sodium-vapor lighting equipment, the newest development in highway illumination, provides light of a strong orange-yellow color, yielding a higher proportion of visible light than other illuminants. About two-and-a-half times as much light is generated as is possible with an incandescent lamp of equal wattage, and the light is efficiently distributed by means of unusual reflectors which are made of a new, specially-processed aluminum.

Sidewalk Plow is the Friend of Commuters and Children.

KEEPING WINTER ROADS AND WALKS OPEN AT WINNETKA, ILLINOIS

TEN snow plowings a winter are provided for in the annual estimate of street expense for the village of Winnetka, Illinois—Chicago suburb on the shore of Lake Michigan, and while this number more nearly represents an extreme than an average requirement, experienced has proved its wisdom. An opposite extreme was represented by the season of 1933-1934.

Street Mileage and Character of Service Required.—Requirements for street and sidewalk maintenance in Winnetka are rigorous. It is a residential community having an area of 3.65 square miles and a population of 12,800 with a high percentage of school children. New Trier high school, located at the south end of the village, is a township institution serving in all four villages and a portion of outlying territory. Its enrollment in 1933 was 2,200.

There are four public grade schools, well scattered in location, and several primary and advanced private schools. Business districts are located at three points, each with steam and electric railway stations serving the large commutation traffic to Chicago.

With small exception Winnetka's streets are level. The two main north and south arteries—Sheridan Road and the Center street-Linden street route—have paved widths respectively of 31 feet and 40 feet, and lengths of 2.5 and 2.4 miles. East and west streets are narrower and serve a much smaller traffic.

Each winter the village forces keep open approximately 80 miles of sidewalk and 20 miles of roadway—all paved. Some 25 miles of secondary road is left uncleared except when very heavy snow renders it impassable by fire equipment.

Procedure When Storms Come.—With the arrival of a storm, efforts are directed first to clearing the sidewalks leading to the railroad stations and the schools, the Sheridan Road and Center-Linden highways, and three or four of the most important east and west roadways. Following these, attention is given as rapidly as possible to the lesser used thoroughfares. It is a matter of village pride that its principal roads and walks are nearly always open in time for the morning traffic to schools, railroad stations, and through highways.

The snow fighting organization is composed partly of members of the street maintenance department, and partly of other village employes—particularly men from the electrical department who are qualified to operate the tractors. Each man has a definite route to cover, and on the arrival of a storm, proceeds to his work without waiting for special orders. For storms beginning at night, the men are called out by the police department.

Roadway Clearing.—Equipment for clearing the roadways consists of two Baker 8-foot blade adjustable truck plows attached to 3 ton trucks, and one large Gettelman blade pushed by a 5 ton tractor. The latter is used only on heavy drifts and for pushing the snow into piles in the business district to facilitate loading and hauling away. The two Baker plows have been in service, one for 5 years and the other for 6. The trucks used to push them are part of the regular village equipment in general use throughout the year.

While one man can operate a plowing unit of the type used in Winnetka, time is saved and other advantages gained by employing two men on each. The shifts, are often long and severe, and the men take turns driving and adjusting the blades, and performing other necessary operations. Sometimes one works alone while the other warms up indoors.

Keeping the Sidewalks Open.—Sidewalk cleaning is done with four LaPlant-Choate Model SW-10 sidewalk plows pushed by Model 10 Caterpillar tractors, and two old 2 ton Caterpillars pulling Baker plows with sled behind; one of these outfits being regularly assigned to each of the six routes into which the village walks are divided. The four new tractors are equipped with rubber faced track shoes, which have proved highly satisfactory. Each unit consisting of tractor and plow is operated by one man.

For light and moderate snow falls, the machines are operated in high gear at an average rate of 3.5 miles per hour. For very heavy snows and under certain

Opening a Road With 8 ft. Adjustable Blade and Three Ton Truck.

especially bad conditions, the intermediate speed of 2.6 miles per hour is used, but most of the work is done at the higher speed.

Speeds exceeding 3.5 miles were considered prior to the purchase of the present equipment, but were ruled out as being unsafe in view of the proximity of trees to sidewalks, the large amounts of overhanging shrubbery and the defective condition of certain walks. It is interesting to note in this connection that the installation of the new equipment has required certain sidewalk repairs which had been postponed up to that time. Not much damage was done to the machines by these defects, but their work was considerably slowed up.

The four Caterpillar-La Plant-Choate units were purchased in 1933, following their use on a rental basis of $100.00 per month each, for 5 months in the season of 1932-33. The rental for that season, however, was applied on the purchase price.

Fuel, lubrication, and all maintenance and operating expense except operators' wages for the four units in the season of 1933-1934 totalled $201.26. This, of course, included no allowance for depreciation.

Horse Power vs. Motor Power.—A comparison of horse power and motor power prior to the purchase of the present equipment yielded interesting results. Many years ago the last of the village-owned horses was disposed of as uneconomic, but as late as 1932 teams and drivers were hired for sidewalk snow plowing at a rate of $2.00 per hour. These were worked in conjunction with the two old Caterpillar tractors, which had been purchased second hand.

However, by 1933, motorization had become so general in the Winnetka district, that it was no longer possible to rent animals on the old basis, and the village was faced with the alternative of motorizing its entire outfit or renting and feeding horses for the full 5 months snow period.

The first step was the rental of the four outfits already described for the winter of 1932-1933. Based on the experience of that season, careful estimates indicated the following costs for a winter of normal snow:

Clearing sidewalks with horse-drawn plows and the two old 2 ton Caterpillars (horses rented and fed for 5 months)	$2,472.00
Clearing sidewalks with motor equipment only—2 old units plus 4 new units to be purchased—interest and depreciation included at 15 per cent per year on the entire equipment investment	1,520.00

The estimate further indicated that had it been possible to rent teams with drivers at $2.00 per hour, as in earlier years, the cost would have been only $950.00 for a season requiring 10 plowings. Unfortunately this could not be done..

Cleaning Up the Businss Centers.—Two other items are to be noted in connection with the winter maintenance of Winnetka's streets. In a bad season the cost of removing snow from the business districts becomes important, having on one occasion amounted to $800.00 for a single storm. It is also to be noted that snow removal is sometimes required when street plowing is not. Removal is carried on with whatever trucks are most readily available. The village garbage and ash trucks serve conveniently for this purpose, at night, and are returned to their regular service in the morning. In emergencies extra trucks are hired from contractors.

Trucks are usually loaded by hand, but for heavy snows a 5 yard snow bucket is used after the snow has been pushed into piles by the plows. This bucket is owned by the village and is operated by a truck crane, for which a rental of $8.00 per hour is paid. The snow is dumped in parks and vacant lots.

Saving the Slips.—Nearly every winter brings ice as well as snow to sidewalks and pavements, and sanding and cindering become important accordingly. Cinders from the village light and water plant are spread on pavement intersections, and torpedo sand is scattered on the sidewalks on hills, of which, as before mentioned, there are few.

Costs.—Costs of winter street and sidewalk work for the past nine years are given below, with the village population accompanying them. There was little change in the mileage of work done over this period, about 80 miles of sidewalk and 20 miles of pavement being kept open each winter. About 2½ miles of main thoroughfare pavement was widened from 27 feet to 40 feet in 1931 and immediately preceding years.

The costs here given include all operating and maintenance expense directly chargeable to snow plowing, snow removal, and sanding and cindering. Interest, depreciation, and overhead are not included. Wages of truck and tractor operators during the past two seasons averaged about 65 cents per hour—in prior years about 75 cents.

Winter	Village Population	Cost of Snow Plowing, Snow Removal, Cindering and Sanding
1933-34	12.813	$ 744.74
1932-33	12,692	3,223.06
1931-32	12,359	1,082.97
1930-31	12,166	3,343.47
1929-30	11,845	3,904.19
1928-29	11,414	3,386.55
1927-28	10,691	1,665.36
1926-27	10,518	1,212.20
1925-26	10,132	1,143.88

Big Blade and Tractor in a Moderately Heavy Snow.

Last Season's Record.—The general record of operation in the winter of 1933-1934—the mildest of the 9 year period—was as follows:

Nov. 14.—Cinders spread on street crossings and sand on walks.

No. 17.—Cinders spread on street crossing and sand on walks.

Dec. 26.—All sidewalks plowed.

Dec. 27.—Al sidewalks plowed and snow removed from business district.

Feb. 5.—Cinders spread on street crossings.

Feb. 7.—Cinders spread on street crossings.

Feb. 18.—All sidewalks plowed; snow 4 in.

Feb. 19.—All sidewalks plowed; snow 4 in.

Feb. 26.—All sidewalks plowed; snow 3 in.

Mar. 26.—All sidewalks plowed; snow 3 in.

There was no plowing of streets during the entire winter.

The information for this article was very kindly furnished by Herbert L. Woolhiser, Village Manager.

NEW YORK OPENS A SCHOOL FOR STREET CLEANING AND SNOW REMOVAL

New York City's newest educational venture, the Sanitation Department's institute of street cleaning and snow removal, opened August 13, was considered by department officials to have proved its success at the end of its first two weeks.

Designed to raise the morale of the department, to increase efficiency and to open the way to promotion for ambitious members of the force, the school is located in a department garage at Twenty-second street and the East River. Deputy Commissioner Paul J. Kiernan, recently elevated from the ranks, is the "dean."

At present there are approximately sixty students. The courses are short, running from one to two weeks. By the end of the year it is expected that more than 1,000 men will have received instruction.

Subjects Taught.—The curriculum of the institute, as it is called by members of the department, is so far somewhat limited. There are courses in truck driving and truck maintenance and courses in the operation and maintenance of snow removal equipment.

Later on the teaching staff will be expanded and other subjects added. Garage chiefs will be taught proper methods of supervision and a uniform method of keeping time books and drawing up payrolls will be explained. Still later the minor officers of the department, section foremen and their assistants will be brought in for instruction and, as a final step the school will add a course designed to improve the efficiency of district superintendents.

Street sweepers are eligible for the truck driving instruction. It is estimated that about 2,000 men now in the department will take this course, since a driver gets about $100 a year more than a sweeper. Some of the new drivers will be named to fill places of drivers now on the job who will be demoted to the sweeper rank for various causes, chiefly for involving their trucks in accidents.

To Spur Snow Removal.—Commissioner Thomas L. Hammond, who set up the school, is most enthusiastic as to its posibilities. He pointed out that the courses in truck maintenance would result in keeping the department's mechanical equipment in better shape. The snow fighting training, he said, would enable the department to prepare much better for snow removal work in the future.

The men taking the snow removal courses, the commissioner explained, are being selected from among the department drivers who have had no experience in operating the various kinds of snow machines.

All Minor Officials Take Course.—Every minor officer in the department will eventually pass through the school, said Colonel Hammond, those recently promoted having first call.

It was largely at the suggestion of Deputy Commissioner Kiernan, who is in charge of the street cleaning phase of the department activities, that the school was organized, Colonel Hammond said. Mr. Kiernan, who was himself long in the ranks, felt that the men were not being properly trained, and that instruction would materially increase the department's efficiency.

Hand Sweeping Not Wholly Obsolete.—About twenty years ago there was a training school in the department for a short time. However, it merely taught sweepers how to wield the pan and broom, which was then standard equipment.

The new school will not concern itself with such elementary instruction. Although department officials are convinced that it will be many years before manual street sweeping can be abandoned, due to the propensity of the public to throw papers and rubbish in the streets, much of the work formerly done by hand is now taken care of by mechanical sweeping and flushing devices.

Acknowledgement.—The foregoing is from *The New York Times* of Sunday, August 26.

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Inter-American Highway

One of the factors that may have an important bearing on American exports is the contemplated participation by the Government of the United States in the construction of the Inner-American Highway. In 1930 Congress appropriated $50,000 for a tentative survey of the location of this highway through the Central American States from Panama City to the Mexican border. This survey has been completed and the results were reported to Congress in January this year. The last Congress appropriated $75,000 for the continuation of surveys of this highway in the Latin American countries. In the Emergency Appropriation Act for the fiscal year 1935, approved July, 1934, Congress also appropriated $1,000,000 to meet such expenses as the President in his discretion may deem necessary to enable the United States to cooperate with several governments, members of the Pan-American Union, in connection with the survey and construction of the proposed Inter-American Highway, the amount to remain available until expended. The expenditure of such sum shall be subject to the receipt of assurances satisfactory to the President from such governments of their cooperation in such surveys and construction.

While regulations covering the expenditure of this million dollars have not as yet been completed, it is evident that in any construction participated in by the United States with the Latin American countries there should be opportunities for the sale of American machinery and equipment.—*Automotive World News, issued by the Automotive-Aeronautics Trade Division, U. S. Department of Commerce.*

A GREAT ITALIAN HIGHWAY ENGINEERING ACHIEVEMENT

ON April 25, 1933, the new bridge between Venice and the Mainland was placed in service with the completion of this great work by the Fascist government, a more than century-old aspiration has been realized, one which has been more pressing in recent times by the need of providing access to the commercial port for motor vehicles, which are now a predominating element in the traffic. An interesting description of this work is given by John Sperni in the January Journal of the Institution of Highway Engineers of Great Britain, from which the notes following are taken.

The new road which is destined to reach Venice leaves Mestre at the foot of the viaduct, which was built across the Venice-Mestre railway line, in place of a previous level crossing.

The new viaduct represents the confluence of all the main roads converging on Venice from Veneto, Padova, Trento, Belluno, Treviso, and from Portogruaro. There is therefore every justification for the departure from the foot of this viaduct of the new road to Venice.

On the whole mainland section the road has a width of 22 m., of which 3½ m. are reserved for footpath and strip of land on the lagoon side, 2½ m. for footpath on the railway side, and 16 m. for the roadway.

The new bridge starts at the edge of the lagoon. It consists of a series of arches, co-axial with those of the railway bridge, repeating the arrangement of the abutment piers and small square bays.

The distance between the new bridge and the previous one is 2.20 m. between shaft and shaft of the face walls. It was thought preferable to leave this air space rather than to join the two structures, to facilitate the building and so as not to imperil the stability of the old bridge.

Between the two a reinforced concrete strip has been put down, which forms a footpath and the junction between the two structures.

The width of the bridge, excluding the projections of the pediments of the breakwaters and of the foundation, is 20 m., and, including the strip referred to above, 22.25 m.

Of this width, 50 cm. are taken up by the parapet on the seaward side, 3 m. by the footpath, and 15.75 m. by the carriageway, and 3 m. by the connecting footpath, which will be used for bicycle traffic.

The bridge is divided up by four bays of 103.70 m. and a fifth central bay of 140.94 m. These are re-made by a thick wall on the sea side, earth and rubbish being filled in up to above the pre-existing railway wall.

Between one bay and another there are seven steps of arches, each set consisting of five arches, except for the central one, which has seven—thirty-seven arches altogether. Between each set of five arches there is an abutment pier of 8.65 m. The central set of seven arches, on the other hand, is bounded by two abutment piers of 13.73 m.

The lay-out of the structure of the adjoining railway bridge is reproduced as far as the fifth bay, where the separation occurs, followed immediately afterwards by a wide curve by which the road takes the direction of the old fort of S. Lucia, crossing the Grand Canal itself at its extremity.

Altogether there are 228 arches, each of 10.63 m., supported by piles of 1.50 m.

The level of the footpath for the whole length of the bridge is on the contour line 3.36 (the railway bridge is on contour 3.352). At arch No. 226 the rise begins, with parabolic connection, so as to pass over the railway line of Marittima with a gradient of 3.4 per cent.

The Grand Canal is crossed by two large arches of 34 m. oblique, and on the slope. The vaults are of bricks with a carriageway above of reinforced concrete.

On the two sides the face walls are built to preserve the appearance of the masonry of the structure, and to face and protect the reinforced concrete from direct salt action.

Marittima is reached with the road level at contour 10.25 at a large square of about 1,500 square metres, from which two roads start—one towards Marittima quays and connecting with the network of roads, especially built to allow motor vehicles to reach the various sheds and to come alongside steamers and the other towards the arrival square for travelers and garage.

The first ramp is 200 m. long and 12 m. wide, with a gradient of 3.8 per cent. It descends from the contour line 3.65, where an ample square has been made for the parking and movement of lorries carrying goods and for parking motor cars, if, owing to exceptional rush conditions, it should not be possible to accommodate them all in the garage or arrival square.

The road for access to the city crosses the railway line and yard in five spans, four being of 20 m. each and the fifth of 9 m. Two of these spans cross the existing railway lines; the other three were made in view of future railway needs, and particularly in the event of the present bridge which connects the station of S. Lucia being moved further towards the lagoon.

The five overhead ways, like the large square facing the lagoon, have the carriageway in reinforced concrete, and the reason for this is that an arched structure would have required the raising of the level of the road even above the level it actually reaches (10.76), with consequent steeper gradient on the approaches, greater volume of masonry, larger foundations, and increased cost. Above all, moreover, this great mass of masonry rising

about 15 m. above the Marittima railway yard, would have introduced a great and possibly unpleasing change into the general appearance of the locality.

After passing the railway lines, and there being no longer any need to have a minimum height of 5 m. over the whole of the span, the previous structure of arches and pillars, of brick and stone, was reverted to, this having been interrupted as stated by the needs of the railway.

By a succession of five arches, decreasing in level and span and arranged parallel to the former Convent of S. Chiara, the Scomenzera Canal is reached; a final arch of 20 m. crosses this canal, and the large arrival square is reached.

This square with its environs covers an area of about 40,000 square metres, 9,000 of which are occupied by the garage which rises immediately to the right hand of anyone arriving, and has a frontage of 110 m. and a height of 23 m.

The contour line of the level immediately after the Scomenzera is 5.4 m.; that is to say, for the whole of that part of the square which constitutes the approach from the road to the garage.

Then with a grade of 3 per cent there is a descent to the terminal square, the useful area of which for maneuvering is about 5,000 square metres on contour line 2.5.

The new road cuts off the main bend of the Grand Canal and substitutes a stretch of 700 m. for the 2,400 m. which would otherwise have to be traversed.

The new highway between Metre and Venice covers a distance of about 10 kilometres. It includes 228 arches in the lagoon; an arches bridge over the Manghera Canal of 15 m.; two large brickwork spans of 34 m. each, over the Grand Canal; three 20 m. spans of reinforced concrete over the railway and one of 9 m.; four brick arches of 15-10 m.; a bridge of 20 m. over the Scomenzera Canal; a square of 40,000 square metres; and a garage for 1,800 cars and an 8-kilometre network of subsidiary roads.

During the period of most intense work, *every day* there were produced, worked and placed in position 100,000 bricks, 200 tons of Istria stone, 500 tons of sand, 800 tons of gravel, 500 tons of broken stone, 150 tons of cement, and 200 piles a day, equal to a length of 2 kilometres.

Altogether 300 kilometres of piles were driven in, equal in weight to 72,000 tons; 20,000 cubic metres of concrete were used, 20 million bricks and 45,000 tons of dressed stone; 8,000 lineal metres of dams for foundation trenches; 2 million days of labor were worked, the maximum number of laborers on any day being 4,600.

On all these works more than fifty pile drivers were used, twenty-three being motor driven; twenty-one floating cranes, eight large hoists, and no less than eight special yards for making the piles; 4 kilometres of subsidiary canals were built and 6 kilometres of aqueducts, two artesian wells, 12 kilometres of electric lines; 200 motors, either electric or internal combustion, were in use.

The materials were brought by sea by means of a fleet of 150 lighters.

The best Italian contracting firms were called upon to compete for carrying out the work by tender, on the specification and quantities of Eugenio Miozzi, Chief Municipal Engineer of Venice.

The cost of the whole work was 80 million lire and it took about twenty months to complete.

The first pile in the lagoon was driven on the 7th July, 1931, and the bridge was inaugurated on the 26th of April, 1933.

More than $1,000,000 for the Inter-American Highway

Under two separate appropriations the 73rd Congress has made available a total of $1,075,000 for the continuation of the surveys on the proposed Inter-American (Pan-American) Highway. The Hayden-Cartright Road Act, approved June 18, 1934, provides $75,000 for continuing the cooperative reconnaissance surveys previously provided for in 1929, when $50,000 was made available for a survey through the Central American Republics from Panama to the southern border of Mexico.

In the Deficiency Appropriations bill for the year ending June 30, 1935, approved June 19, 1934, $1,000,000 is provided to meet such expenses as the President, in his discretion may deem necessary, to enable the United States to co-operate with the several governments, members of the Pan-American Union, in connection with the survey and construction of the proposed Inter-American Highway. The funds are to remain available until expended. The expenditure of this sum is to be subject to the receipt of assurance satisfactory to the President from such governments of their co-operation in such surveys and construction.

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Road Oiling Means Motoring Comfort

This is the season in which motorists enjoy "razzing" the engineers responsible for oiling the roads and establishing detours around construction projects, says a bulletin of the Minnesota Highway Department.

Some motorists probably think these engineers have deliberately plotted against their Sunday afternoon enjoyment of some particular stretch of highway. But if the highway department failed to apply the needed bituminous treatments, the motorist would have poor driving for the next twelve months, instead of some slight inconvenience for a few minutes or few hours with the freshly applied black surfacing.

And if there were no detours, there would be no nice, modern roads to drive on. Construction activity brings temporary detours which make possible years of driving comfort over improved highways.

The state highway department, in applying ordinary retreatments to bituminous roads, treats only half the roadway at a time. It covers the fresh material with gravel or sand immediately after application. It keeps flagmen on the job while the treatment is in progress, and these men warn drivers to go slowly over the treated stretch. If cars go slowly they do not spatter the bituminous material, but if they speed they will pick it up off the road. Bituminous treatments must be applied during the summer months.

If cars become spattered with bituminous road surfacing, highway department chemists recommend the following cleaning method: Mix one quart lubricating oil with one gallon of gasoline. Do not use gasoline containing lead compounds, such as ethyl gas. Spray or brush the mixture on the spots to be cleaned. Let the gasoline evaporate, then wash twice with soap and lukewarm water.

PROTECTION OF TREATED TIMBER IN THE FIELD

Rules Proposed by the American Railway Engineering Association's Committee on Wood Preservation at 1934 Convention

Bridge Timber

1. Timber is creosoted to protect it from decay, and any cutting that exposes the untreated interior is injurious to life of timber and renders it very little better than untreated material.

2. When ordering treated timber state exact sizes and lengths desired. Cutting treated timber to length in the field shortens its life and should be done only when unavoidable.

3. When cutting to length is unavoidable or when necessary to adze or otherwise disturb the surface of treated timber, such surfaces must be swabbed with a liberal quantity of hot preservative followed by two applications of hot sealing compound.

4. When necessary to bore treated timber in the field, all holes must be treated with hot preservative, followed by sealing compound applied hot, and the bolt immediately driven home.

5. When unused holes are left in treated timber or piling they must be treated with hot preservative and filled with treated plugs. Before driving the plugs must be dipped in hot sealing compound.

6. It is recommended that timber be allowed to season for at least 60 days after treatment. It should be piled with spacer strips to give complete air circulation. In addition to other advantages the fire hazard is greatly reduced when treated material is allowed to season about 60 days after treatment. It has been demonstrated that seasoned creosoted material is more resistant to fire than either seasoned untreated or freshly creosoted material.

7. Creosoted timber piled for seasoning or storage should be sheltered as much as possible from direct rays of the sun. Cross sticks should be placed sufficiently close to prevent long timbers or those of small section from sagging and becoming crooked, and every care should be taken to prevent the checking which exposes untreated wood. The top layers of stacked timbers should be covered with sand or dirt to the depth of not less than ½ in. as protection from the sun, and all grass or rubbish should be cleaned from under and around the stacked material to lessen the danger from fire.

8. Creosoted lumber, and particularly long or heavy timbers which have been framed prior to treatment, should be stacked with special care to avoid warping or distortion while the material is in storage.

9. In handling treated material, extreme care should be used to avoid damage to the edges of the timbers or breaking through the portions penetrated by the treatment and exposing untreated wood. The use of peavies, canthooks, timber dogs, pickaroons, lug hooks, or other pointed tools on treated lumber should be absolutely prohibited.

10. Care should be exercised in the proper placing of creosoted caps to obtain long life or service. If season checks have developed more in one face than in the other, that face should be placed down to prevent infection from moisture entering through such season checks.

11. Sway braces should be fitted from the bottom and any cutting to length found necessary should be at the top. The cut should then be treated with hot creosote, creosote and bridge cement, or roofing pitch and fabric as necessary to protect it from the weather.

12. Where the piles in a bent vary in size or are out of line filler blocks shall be used between the braces and piles, securely fastened and faced to obtain a bearing against all piles. Treated filler blocks shall be used with treated braces.

Piling

1. Treated piling placed in storage yards should be carefully stacked. Consideration should be given in method of stacking to allow access to water throughout the stacks that fires may be readily extinguished.

2. Piling should be yarded or stored with entire length at rest, which prevents sagging and bends, thus eliminating danger from fracture when driven.

3. When stacked on right of way at location of bridge, and if not used promptly, they should be stacked in area free from dead grass or other combustible materials.

4. It is necessary that piling be driven to full resistance which insures a finished structure which holds firm in service with no settlement of bents, and it is equally important such driving be accomplished without injury to the material.

5. The use of dogs may be employed in rafting piles provided these are placed within 1 ft. of the head or 4 ft. of the tip. Rope slings should be used for unloading and handling. Tongs may be used when confined to the ends as outlined above for lifting so that slings may be placed. A sharp pointed tool should not be used to turn a pile in the gins of the driver. This can be done with a spud and sling. Piles should not be bored for staging. For piling driven in water or with the cut-off high above the ground, staging clamps may be used. These may be made of two flat bars, bent to semi-circles and bolted together around the pile. A tail turns up at

one end of the iron and projects sufficiently to carry the supporting timber on which the staging plank is laid.

6. All treated pile cut-offs and chamfered tops where the piles project beyond the caps should be saturated with hot creosote by repeated applications, and then daubed with hot asphaltum or a mixture of creosote and roofing pitch mixed to a vaseline-like consistency, and swabbed in with a long-handled brush. For chamfered tops it is recommended that suitable fabric be embedded in the hot asphaltum, or roofing pitch and creosote, and that the outside of this fabric be given an additional coating of the water-proofing material.

7. Holes bored for drift pins should be 1/16-inch smaller than the drift. This is not recommended for sway brace bolts, as the thread of the bolt has a tendency to sliver the pile on the opposite side. Where possible holes bored in creosoted material should be filled with hot creosote followed by a mixture of creosote and roofing pitch. After the hole is driven a portion of the pitch-creosote mixture should be placed under the washers at both ends of the bolt which, when the bolt is tightened, gives a water-tight job under the washers.

Pitch can usually be worked in between the timbers before tightening to give further protection. With proper care, decay from sway brace bolt holes can be practically eliminated.

Any holes that may be made either in top or side surfaces and which are not used should be plugged with treated material. The plug should be dipped in creosote and driven to the bottom of the hole. Holes, abrasions, or checks too large to be plugged should be treated with hot creosote and filled with the mixture of creosote and roofing pitch. This may then be protected by sheet copper held in place with copper nails or by special roofing material laid with the weather side out and coated with the pitch mastic on the outside.

Bridge crews handling creosoted piling and other creosoted material should keep on hand a supply of creosote, bridge cement, or roofing pitch, saturated fabric, and creosoted shimming and plugging material.

8. Treated piling or timbers should not be cut or punctured when inspecting same. When there are indications of decay in interior of piling or timbers, same should be bored, care being taken to swab the holes with preservative and plug same with creosoted plugs.

Treated Telegraph Poles

1. To obtain maximum life service it is necessary to avoid gaining and boring of poles after treatment. They should be gained for cross arms, roofed, if specified, and all necessary holes bored prior to treatment as indicated by standard plan. All gains should be cut accurately and parallel so that cross arms will be in vertical alignment, thus eliminating any necessity of having to regain or bore into the treated wood.

2. After treatment poles should be carefully handled so that treatment is not punctured by grab hooks or fractured by impact. When possible, poles should be unloaded by crane or derrick.

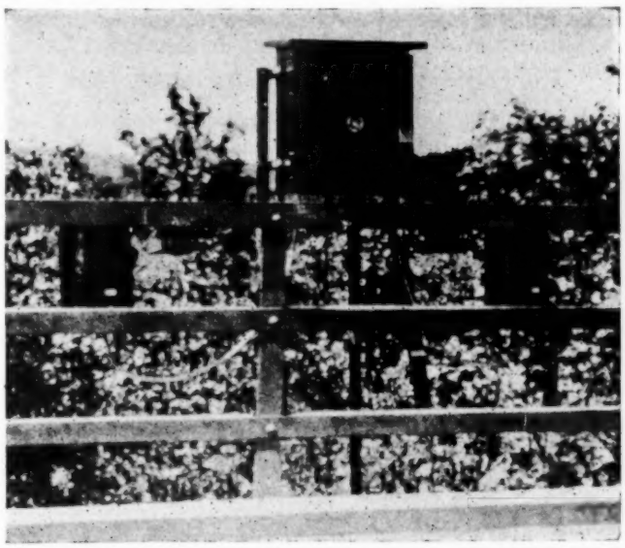
3. All poles should have treatment of sufficient depth so that lineman's climbers will not penetrate through the treated wood which may cause infection and decay.

4. Poles in service should have grass and weeds cleared over sufficient area to prevent burning or damage by excessive heat which would cause creosote to exude from pole when overheated.

5. If necessary that any poles be framed or bored in the field, all newly framed or bored surfaces should be protected with applications of hot creosote.

Two-Way Photoelectric Counter Checks Toll-Bridge Traffic

Officials of the toll bridge at Cairo, Illinois, wishing to obtain a traffic counter sufficiently automatic in operation to signal the number of tolls registered at the tollhouse to an inspector stationed at the opposite end of the bridge, have installed photoelectric equipment. The installation keeps an individual record of both directions of traffic, and is remarkably accurate and fool-proof in operation.



Photoelectric Traffic Counter at Cairo Bridge

Two beams of light are used. The order of their interruption indicates the direction in which a given car is traveling. These beams are directed horizontally across the road at an angle of 20 degrees. The angle prevents reestablishment of a beam between the rear of a car and its spare tire, trunk, or other projection which might interrupt the light beam and cause false counts. The height at which the beams are located was very carefully chosen to prevent false registry caused by pedestrians, by trailers, or by the possibility of the beam's "shooting" under the bodies of large trucks.

Since the equipment is located within easy reach of "tamperers," a number of safeguards are provided. The light source and photo tubes are enclosed in padlocked, weatherproof cases, and three devices installed within the counter cabinet tend to minimize the errors caused by outages or by attempts to make the device inoperative through intentional blocking of the light beam. After an outage of a few seconds a bell alarm is set off and continues to ring until the trouble is cleared and the equipment is restored to operating condition. In addition, an outage counter registers the outage. At the same time a self-starting Telechron clock, normally set at 12 o'clock, starts to run—thus indicating to the second the length of time that the machine is out of service.

During the two-week period covered by the last report, only two outages were registered and both were due to external causes. To date, more than 40,000 vehicles have been satisfactorily counted by the equipment. General Electric Co. was the manufacturer.

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Snow Removal in Toronto.—The total snow fall in Toronto, Canada, during the winter season of 1932-33 amounted to 2 ft. 1 in., being the lightest snow fall in many years. Snow removal and sanding of crossings, and cindering of roadways is performed by the Department of Works and Department of Street Cleaning jointly.

ENGINEERING AS A PROFESSION

A Canadian View, Expressed in an Editorial in The Engineering Journal of August, 1934

ON THIS side of the Atlantic the term engineer suggests to the ordinary citizen either an experienced railway man who drives a locomotive, or a youth in khaki who peers through a three-legged telescope and whose mysterious activities finally result, somehow, in the construction of an enormous dam or bridge. The public in fact is hardly aware that engineering is a profession. It is therefore reasonable to enquire just what is a professional engineer and what is implied by the word profession as applied to engineering.

There are a multitude of occupations whose practitioners claim the title of engineer; some of these can properly be classed as professional work, while in other cases the claim is put forward by a man who has had no training as an engineer in an endeavor to obtain a status or consideration to which his technical requirements and occupation do not really entitle him.

In discussing this matter, reference is often made to two of the "learned" professions, law and medicine, and engineers sometimes feel a slight twinge of envy when they note the manner in which lawyers and doctors (to say nothing of architects) have been able to regulate their professional activities and their relations with the public. They have undertaken certain duties towards their clients and have justly obtained certain rights and privileges which are duly safeguarded. The engineer asks himself to what extent it is possible or desirable to build up a like system for engineering work, with the two-fold aim of protecting the public against incompetent practitioners and protecting the members of the profession against improper or unfair competition.

Such a system necessarily involves the establishment of an approved standard of general and professional training, and adequate control of the right to practice.

In Canada much has already been done along these lines, but much remains to be accomplished. The Engineering Institute of Canada, like most other societies of similar standing, has insisted upon certain educational and professional qualifications before membership is granted, and has emphasized the value of systematic training and a high standard of professional attainment. The Professional Associations have continued the work by obtaining, in some of the provinces at any rate, adequate powers to give legal authority to requirements of the kind. Progress is being made, but is necessarily slow, by reason of many difficulties, some external to the profession, and others due to the very nature of engineering work.

In framing any scheme for the regulation of our professional work, consideration has to be given to such matters as the great diversity of engineering activities, the various kinds of training required for their successful prosecution, the engineer's relation to the employers or clients for whom he acts, and the extent to which his work is specialized. It must not be forgotten that in order to be successful, his efforts must always meet definite financial requirements. In some cases, for example, his services are performed for the purpose of selling engineering materials or equipment, his training and experience enabling him to advise the purchaser as to the selection he should make to obtain the best and most economical results. It will be seen that in many aspects of the engineer's work, his profession differs essentially from that of the lawyer or medical man, for the engineer is always limited by economic considerations, and he deals with materials and their utilization, rather than with people and their troubles and difficulties.

An admirable survey of the many problems relating to engineering as a profession was given by the President of the American Society of Civil Engineers at the Annual Convention of the Society which has just been held in Vancouver together with The Institute's Western Professional Meeting. President Eddy's address* points out that a profession has been defined as a vocation characterized by specialized educational training, which has for its purpose the supply of disinterested counsel and services in return for a definite compensation, "apart from expectation of other business gain." He enquires as to how far engineering, as practiced today, complies with these requirements, and comes to the conclusion that engineering is certainly a profession in the sense contemplated by the definition, and further, that in view of the dependence of the engineer's work upon the application of so many sciences, it may fairly be regarded as a learned profession. Taking his own special branch as an example, Mr. Eddy remarks that the sanitary engineer has recourse to hydrology, chemistry and bacteriology for information as to the quantity and quality of a water supply; to hydraulics and applied mechanics for the design of his structures; to metallurgy, soil mechanics and many other branches in connection with others of his problems. The trend today is towards an ever-increasing application of scientific knowledge and the utilization of the results of research, and this applies to all branches of engineering.

These increased demands on the engineer's scientific knowledge have involved marked development in engineering education, and post graduate work, either scholastic or extra-mural, is now "a necessity for one who is to secure more than mediocrity in engineering."

Many engineers exercise both technical and business functions, which are not easy to separate. A contractor, for example, may function as an engineer in planning his methods of handling construction, while carrying on the business of managing, organizing and financing his work. The technically trained sales-engineer in many cases renders strictly professional engineering services

*"Trends in Engineering as a Profession in the United States of America." Address at the Annual Convention Vancouver, B. C., July 11th, 1934, by Harrison P. Eddy, President American Society of Civil Engineers.

on behalf of his employer, and along with this development there has arisen a tendency on the part of large corporations towards commercializing engineering practice, which Mr. Eddy deplores. He has observed the growth of industrial and other companies whose operations in the field of engineering advice and design have encroached greatly upon the independent practice of the individual professional engineer. It is also noteworthy that an increasing proportion of the engineering profession consists of employees instead of independent practitioners, and this change has been accompanied by more detailed specialization, so much so that in many cases an engineer finds himself occupied continuously with problems of substantially the same kind, his work thus giving him no opportunity for broad experience.

As regards engineering societies, Mr. Eddy remarks that these perform an indispensable service, but there is to some extent overlapping and duplication of effort in their work of disseminating professional knowledge. In the United States he notes that greater stress is now being laid on the organization of the profession, as is shown by the fact that twenty-eight states now have registration laws, while the voluntary societies have made great efforts to foster the social branches of their work, particularly in connection with the unemployment of their members. He concludes that "the trend is unmistakable towards better things for the community, the profession and the individual engineer, to be secured in large measure by the co-operative effort of engineers made effective through engineering societies." The task which he outlines for these bodies is a huge one, and effective advance cannot be made without the individual participation of their members in the societies' work.

If the desired aim is to be reached, organizations like The Institute, whose main object is the acquirement and interchange of professional knowledge, must work in harmony with those other bodies whose duty it is to regulate the practice of professional engineering.

Ultimately the public estimation of the engineer as a professional man depends upon the competence, integrity and personal character of individual members of the profession. Membership in our engineering societies and professional associations must be regarded by the public as a guarantee of these qualities if professional recognition is to be generally accorded to the engineer.

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Highway Mileage and State Fair Attendance

Attendance at the California state fairs of 1923 and 1933 followed an interesting parallel with highway mileage at the same periods.

CALIFORNIA HIGHWAY MILEAGE

Type	1924 Miles	1934 Miles
Earth	1,523	4.056
Untreated rock surface	734	390
Bituminous treated rock surface	346	4,350
Pavement	2,019	4,777
Unimproved	1,778	501
Totals	6,400	14,074
Per cent increase		45

CALIFORNIA STATE FAIR ATTENDANCE

1923	138,499
1933	327,069
Per cent increase	42

Charles W. Paine, Secretary-Manager of the state fair, attributes the increased attendance very largely to highway improvement. Attendance and mileage have run closely parallel throughout the entire 10 year period. 1934 attendance is expected to exceed 400,000.

International Work on Testing Emulsions

International cooperative work has been inaugurated recently on the testing of emulsions. This work grew out of the 1933 World Petroleum Congress held in England, in which a number of papers were given and discussed on methods of testing bituminous emulsions. Discussion by the various interested parties brought out the possibility and desirability of international work on standardizing test methods, and as the result of an invitation to cooperate in the work, the A. S. T. M. is taking an active part through its Committee D-4 on Road and Paving Materials, immediate jurisdiction of the work being in the province of Subcommittee B-17 on Emulsion Tests, headed by Mr. J. S. Miller, Jr., of the Barber Asphalt Co.

Col. E. G. Wace, chairman of the Roads Emulsion and Cold Bituminous Roads Association, Ltd., of England, has taken a leading part in the work. He recently forwarded a sample of a bituminous emulsion, with an outline of the tests to be used, to those participating.

The tests to be conducted upon the sample cover the following properties: Water content; homogeneity or spraying quality; viscosity (Engler); lability in use; and resistance to low temperatures. The samples received here have been tested by two members of Subcommittee B-17 and it is expected that a compilation of the results obtained by the various cooperators will prove of considerable interest.

Tests included in specifications for emulsified asphalt being submitted to the society for approval as tentative, involve viscosity (Saybolt); residue by distillation; settlement (5 days); demulsibility; sieve test (homogeneity or spraying quality); stone coating test; tests on residue by distillation: Penetration at 25 C., solubility in CS_2, ash, ductility at 25 C., specific gravity at 25 C.

Further announcements of this international cooperation work will be made as developments occur.—*Bulletin, American Society for Testing Materials.*

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Minnesota Truck "Chiselers" Fined for Overloads

Attempts at "chiseling" have proved costly to a number of truck owners using the Y license, says a Minnesota Highway Department bulletin. Officers of the highway patrol are continually checking on the weights carried by Y trucks, and half a dozen truckers who overloaded their vehicles were fined in the first few days of August in various parts of the state.

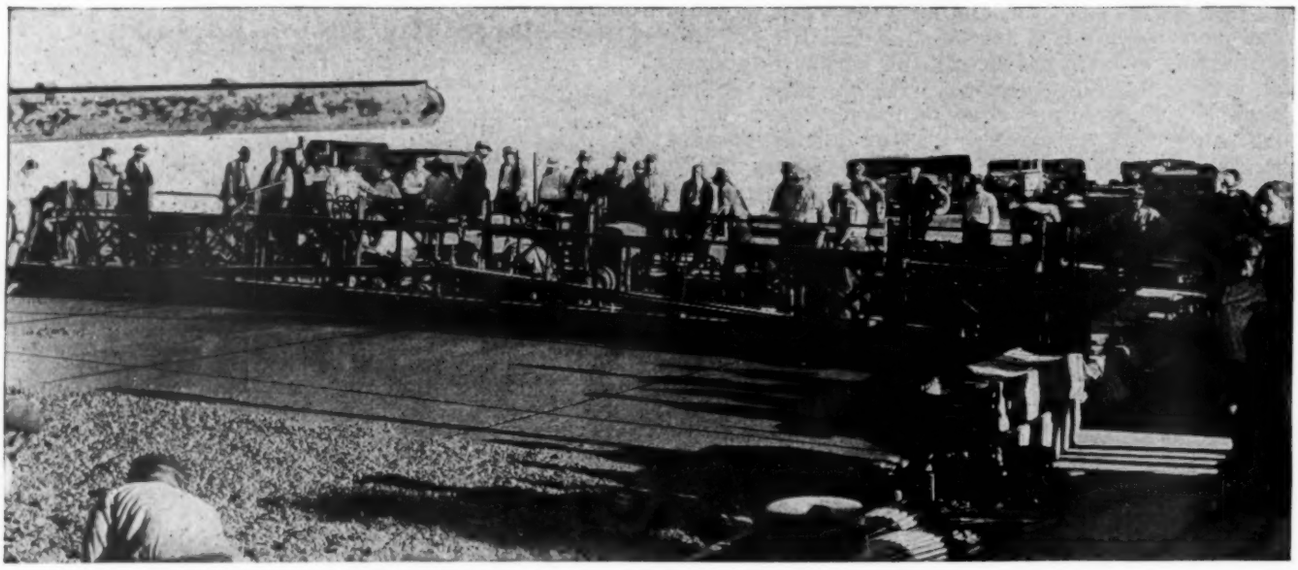
When truckers are found to be carrying more than the stated amount permitted by their Y license, they not only are taken into court and fined, but are also required to pay heavy license penalties. In a typical case a Minneapolis trucker was hauling 22,900 pounds in a vehicle authorized to carry only 16,000 pounds. He was fined $50 and had to pay $35 additional in license penalties.

▼

9,152,282 Miles of Highways in World; U. S. Has One-Third.—A survey just completed by B. P. Root of the Department of Commerce shows that the United States has one-third of the total highway mileage of the world.

His survey covers 145 countries and political subdivisions and shows a total of 9,152,282 miles and 3,042,780 for the United States.

Russia is second with 1,682,109 miles of highways recorded. Japan is third with 635,399 miles of highway.



Finishing Machine on Cleveland Ave., Canton, Ohio

Forty-four Foot Finisher on Canton, Ohio Job

A recently completed two-mile pavement on Cleveland Ave., Canton, Ohio (State Project No. 68, Route No. 8), involved a number of interesting features, including the use of a finishing machine 44 ft. wide, adjustable to 50 ft., and weighing 6 tons. The screed weighed 2 tons.

Grading was started April 6, 1934, and the street was opened to traffic July 2, four months ahead of schedule time. The surface was tested by the Ohio State Highway Department and found to meet all state requirements. The job created a great deal of public interest, and a civic celebration was held in observance of its completion, as Canton's best paved street.

The finisher was a special order, made by the Flexible Road Joint Machine Co. of Warren, Ohio. It was mounted on 8 wheels.

Due to the weight of the machine and screed, it was believed the forms would "shimmy" and tip inwardly; therefore, an extra track wheel was placed on each side of machine to ride on the outside of base of the forms to prevent tipping. No tendency to tip or "shimmy" developed, and the extra wheels were accordingly removed soon after the work started.

Mounted on finisher, directly back of the screed, were three Flex-Plane longitudinal joint installers, which fed ⅛ in. by 2½ in. asphaltic ribbon (in 100 ft. lengths) into the road, and transversely 44 ft. across the road at intervals of 25 ft.

Concrete was supplied by two 27-E Foote mixers.

Garaux Brothers Co. of Canton were the contractors. The engineers in charge were W. C. Neff, Ohio State Resident Engineer, and Luther Zerbe, County Resident Engineer.

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Canadian Good Roads Association Tentative Program of Convention, September 11, 12 and 13

The twenty-first annual convention of the Canadian Good Roads Association will be held at the Manoir Richelieu, Murray Bay, Quebec, September 11 to 13 inclusive.

The program as tentatively announced is as follows:

Tuesday Afternoon, September 11

2:00 *p. m.* Registration of delegates in the Casino.

3:00 *p. m.* First Session.

Convention called to order by the President, Hon. J. E. Perrault, K.C., Minister of Highways and Mines, Province of Quebec.

Address of welcome by the Honorable E. L. Patenaude, Lieutenant-Governor of the Province of Quebec, who will officially open the Convention.

Address of welcome by the Hon. L. A. Taschereau, Prime Minister, Province of Quebec.

Address of welcome by J. Ernest Carré, Mayor of the Village of La Malbaie, François Bhérer of St.-Etienne de La Malbaie, Hector Warren, Mayor of Pointe-au-Pic.

Addresses of response by various members.

4:00 *P. M.*

Presiding Officer: Hon. J. E. Perrault, K.C.

SUBJECT: "Foundations and Protection Against Heaving by Frost."

LECTURER: Alphonse Paradis, Chief Engineer, Department of Highways, Province of Quebec.

DISCUSSION: R. M. Smith, Deputy Minister of Highways, Province of Ontario.

SUBJECT: "The Future Trend in Financing Taxation and Expenditure."

LECTURER: W. G. Robertson, Manager, Canadian Automobile Association, Toronto, Ont.

DISCUSSION:

Hon. D. A. Stewart, Minister of Public Works, Province of New Brunswick.

Hon. A. S. MacMillan, Minister of Highways, Province of Nova Scotia.

Hon. W. R. Clubb, Minister of Highways, Province of Manitoba.

Col. J. L. Boulanger, Deputy Minister of Highways, Province of Quebec.

Tuesday Evening, Sept. 11

7:00 *P. M.*

Canadian Good Roads Association Directors' Dinner Meeting. Special tables. Main dining room.

8:30 *P. M.*

Musical Program, Motion Pictures, and Dancing in the Casino.

Wednesday Morning, Sept. 12

9:30 *A. M.* Second Session.

Presiding Officer: Hon. T. B. McQuesten.

Appointment of Nominations and Resolutions Committees.

ADDRESS: Hon. G. Shelton Sharp, Minister of Highways, Province of Prince Edward Island.

ADDRESS: "Safety on the Highways." Lt. Col. Arthur Gaboury, General Secretary, Province of Quebec Safety League, Montreal.

SUBJECT: "General Maintenance."

LECTURER: Alphonse Gratton, District Engineer, Department of Highways, Province of Quebec.

DISCUSSION: W. A. S. Melanson, District Highway Engineer, Province of New Brunswick.

M. A. Lyons, Chief Engineer, Province of Manitoba.

SUBJECT: "Economical and Safety Aspects of Cement Concrete Construction."

LECTURER: Frank T. Sheets, Consulting Engineer, Portland Cement Association, and former Chief Engineer, Illinois State Highway Commission, Chicago, Ill.

DISCUSSION: A. A. Smith, Chief Engineer, Department of Highways, Province of Ontario.

Omer Martineau, Assistant Chief Engineer, Province of Quebec.

J. Antonio Lalonde, C.E., Chief Engineer, A. Janin & Co., Ltd., Montreal.

C. D. French, President, Kennedy Construction Co., Montreal.

12:00 *Noon*

Meeting of Nominations Committee in the Murray Room.

12:30 *P. M.*

Meeting of Resolutions Committee in the Murray Room.

12:45 *P. M.*

Group Photograph of all delegates, St. Lawrence River terrace, Manoir Richelieu.

Wednesday Afternoon, Sept. 12

Golf, Salt Water Bathing, Tennis, Riding.

2:30 *P. M.*

All delegates are invited to take part in a motor tour over several highways in the Murray Bay district to nearby places of scenic and historic interest, as guests of the Highway Department of the Province of Quebec.

Wednesday Evening, Sept. 12

9:30 *P. M.*

Musical Program, Motion Pictures and Dancing in the Casino.

Thursday Morning, Sept. 13

9:30 *A. M.* Third Session.

Presiding Officer: Hon. D. A. Stewart.

ADDRESS: Hon. A. S. MacMillan, Minister of Highways, Province of Nova Scotia.

ADDRESS: "The Trans-Canada Highway." W. H. McIntyre, President of the Ontario Motor League.

SUBJECT: "Regulating the Common Carrier Vehicle."

LECTURER: J. P. Bickell, Registrar of Motor Vehicles, Province of Ontario.

DISCUSSION: G. L. Ingram, Registrar of Motor Vehicles, Province of New Brunswick.

H. R. Mallison, Vice-President, Province Transport Co., Montreal.

Colonel F. M. McRobie, President, Canadian Transfer Co., Montreal.

R. W. H. Douglas, Acting Registrar of Motor Vehicles, Province of Nova Scotia.

SUBJECT: "New York State's Experience with Low-cost Bituminous Surfaces."

LECTURER: David Noonan, Deputy Commissioner of Highways, State of New York.

DISCUSSION: Engène Pelletier, Divisional Engineer No. 1, Province of Quebec.

Thursday Afternoon, Sept. 13

2:30 *P. M.* Fourth Session.

Presiding Officer: J. A. Duchastel de Montrouge, M.E.I.C.

ADDRESS: Hon. Frank Carrel, M.L.A., Province of Quebec. Subject: "Observations Made in Gaspé and in a Foreign Competitive Country on the Tourist Business."

SUBJECT: "Exporting Our Historic and Scenic Charm."

LECTURER: A. Bergeron, Assistant Deputy Minister of Highways, Province of Quebec.

DISCUSSION:

D. Leo Dolan, Director, Canadian Travel Bureau, Ottawa.

Hon. A. E. Arsenault, President, Prince Edward Island Tourist Association.

Theodore G. Morgan, President, Montreal Tourist and Convention Bureau.

B. T. Fay, Empire State Tourist Council, Albany, N. Y.

C. K. Howard, Convention Manager, Canadian National Railways.

J. Murray Gibbon, General Publicity Agent, Canadian Pacific Ry. Co., Montreal.

A. Pion, President, Quebec Provincial Motor League.

J. E. Renaud, Manager, Quebec City Tourist Bureau.

SUBJECT: "Regulating Tourist Accommodation."

LECTURER: Loic Trudel, Director Hotel Branch, Treasury Department, Province of Quebec.

DISCUSSION: T. J. Leahy, President Adirondack Resorts Association, Lake Placid, N. Y.

V. G. Cardy, President, Province of Quebec Hotel Association, Montreal.

J. L. Gagnon, President, Country Hotel Keepers' Association of Quebec, Montreal.

P. E. Rice, President, New York State Hotel Association.

J. J. Meagher, K.C., President, Royal Automobile Club of Canada, Montreal.

Harrie B. Coe, Manager, Maine Publicity Association.

SUBJECT: "Snow Control and Treatment of Ice Surfaces."

LECTURER: A. Courchesne, Divisional Engineer, Province of Quebec.

DISCUSSION: John Sears, Divisional Engineer, Ottawa District, Province of Ontario.

J. R. Collins, General Superintendent, Provincial Transport Company, Montreal.

Thursday Afternoon, Sept. 13

5:00 *P. M.*

The Annual General Meeting of the Canadian Good Roads Association will be held in the Casino, Manoir Richelieu, Murray Bay, on Thursday afternoon, September 13th, at five o'clock.

BUSINESS: Reception of Annual Reports and Financial Statement.

Election of Directors and Officers.

Appointment of Auditor.

General Business.

Meetings of the newly-elected Board of Directors and the Executive Committee will take place immediately after the Annual General Meeting.

Thursday Evening, Sept. 13

7:30 *P. M.*

Annual Dinner, Main dining room, Manoir Richelieu —informal dress.

Dancing in the Casino following dinner.

Further information may be obtained from Geo. A. McNamee, Secy.-Treas., Canadian Good Roads Assoc., New Birks Bldg., Montreal, Que.

EDITORIALS

Salvation Through Road Building

At the risk of overworking a hackney, the editor again calls attention to road construction and improvement as a means of relieving the terrific problem of unemployment. One can think of a score of ways in which surplus labor could be absorbed with benefit to all concerned (better housing is one of the most important) but not housing or any other of the lot compares with road and street work in the combined advantages of quick, large scale, nation-wide results.

The fact that nearly half a million men are now engaged directly on street and highway projects should blind no one to the further opportunities in the field. Surveys are complete and plans ready for numbers of desirable projects which are dormant either because of lack of funds or because authorities hesitate to start more road work when so much is already being done. Even work as yet unplanned can be got under way quickly, for preparatory details for road construction and improvement are simple in most cases.

It is foolish to beg the question of unemployment and what it involves. We have it on a grand scale, and while conditions are improving, the absorption of labor in ordinary ways—ways not deliberately planned to that end—will require many years. In the meantime, the country must provide work or charity. There is no third alternative, for we are in an era which will not tolerate starvation.

Unfortunately we can not be sure that jobs will be given, rather than relief. It requires more courage, more energy, more skill, more moral sense, to find men work than to pay them a dole. Our present huge relief rolls are evidence of the difficulties, and this statement is intended as no slight to the heroic efforts which have been made to reduce them.

We admit that we are highway enthusiasts, but we believe we are moved by no undue bias when we insist on this superiority of road work as a means of unemployment relief. It combines the two really essential features—the accomplishment of desirable and useful (in many cases necessary) construction, with immediate effectiveness in supplying work.

In considering what undertakings should come first, we are confronted by an "embarrassment of riches"; but it seems to the editor that the elimination of traffic hazards is the most pressing. In 1933, auto fatalities totaling approximately thirty thousand were recorded in this country. This year they are apparently running twenty percent higher. A large proportion of all these deaths, and the hardly less tragic maimings (there were eighty thousand permanent injuries in 1933) is preventable by proper construction at railroad crossings and highway intersections.

Less than a month ago, the twenty-fourth auto fatality occurred at a railway crossing a few miles north of Chicago—an extreme case perhaps, but scarcely unique; and at any rate, who shall quibble as to whether a given hazard has cost twenty-four lives or fourteen, or merely a paltry four?

Following the correction of highway danger spots, a variety of work presses for accomplishment. The farmers' roads, in spite of all that has been done, are still far behind his economic and social needs. Almost every city has important streets which are a disgrace—streets which put more wear and tear on a car in a few blocks than do miles of driving on the country roads leading to them. We are justly proud of our through highways, yet our Federal aid system is little more than half complete. We think we travel fast, but the demand for greater speed is here, and roads must be adapted to it. The nation has 24,000,000 motor vehicles—several times the number once designated as the saturation point—but assuredly we must look forward to more.

Here are the needs of highways on the one hand and of work on the other. The work should go into the highways except where more worthy undertakings can be found for it. Every day lost is waste, and worse than waste.

The great problem undoubtedly is finance, but let us face it squarely, admitting that government must either pay men for working or support them in idleness. Private industry can not come to the rescue in time, if at all. Courage, energy, skill, moral sense are the requisites. Pray God that our leaders have them!

▼

New Ideas in Road Beauty to Be Tried in Minnesota

A ten-mile roadside development project which should give Minnesota one of the finest examples of such work in this part of the United States has been started on U. S. Highway 61 on the north shore of Lake Superior, according to an announcement by the state highway department. The task will require a year for completion.

While the highway department is planning the roadside activities, the work will be done by the Civilian Conservation Corps and the necessary materials will be provided by the National Parks service. Practically no expenditure of state highway funds will be required.

The North Shore project begins near Lutsen and extends about two miles north of Cascade. Here, in a naturally wild and beautiful setting, closely skirting the lake shore, new ideas in highway beautification and safety will be put into practice.

Steep side ditches and sharp, ugly cuts will be reduced to safe, gentle slopes covered with native ferns, wildflowers and other wild vegetation of the countryside. The highway, instead of being a raw gash through the woods, will be made to harmonize with the scenery so that the edge of the right-of-way will blend imperceptibly with the wilderness.

Undesirable brush, dead wood and fallen trees will be cleared away along the roadsides. In some places carefully planned thinning of woods will be carried out to open up vistas along trout streams or out upon the lake. In other spots native trees and shrubbery will be planted. Guard rails of rustic construction are planned.

At Cascade, where the Cascade river flows into Lake Superior, a roadside parking area large enough to accommodate forty automobiles will be constructed. A native stone concourse will overlook the lake, while on the other side of the highway foot trails will lead back into the woods along the river banks.

Here the state owns 2,000 acres of land in the Superior national forest. A CCC camp is being built at Cascade to house the young men who will carry out the work. In addition to roadside activities they will construct a firebreak around the state land and build trails under the direction of the state conservation department.

NEW EQUIPMENT AND MATERIALS

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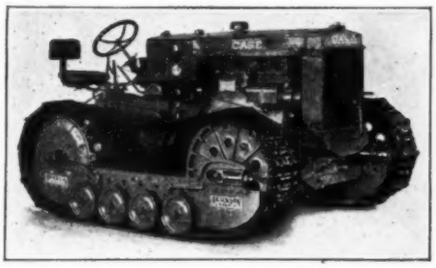
New Heavy-Duty Tractor

The Model GL Trackson-Case Crawler-Tractor has just recently been put into production by the Trackson Company of Milwaukee, Wis.

The unit is powered by the Model L Case motor, weighs 8,000 pounds and develops approximately 40 drawbar horse-



Model GL Trackson-Case Crawler-Tractor

power. This ratio of power to weight meets the demand for maximum power with minimum weight. Its track area in contact with the ground is extra large, and harnesses the power so completely that the effective drawbar pull is unusually high.

Designed to work with super-imposed auxiliary equipment, the GL tractor has a low center of gravity, wide tread and special balance to provide the best stability with front, rear and side loads. The crawlers have extra large load supporting bearing area, great structural strength and provisions for proper inbuilding of equipment, such as booms, cranes, hoists, etc.

The improved heavy-duty crawler track has single drive lugs that form a rail upon which the front and rear crawler wheels run. The front wheels are of sheave type, while the rear wheels have drive teeth independent of guide flanges. This design assures positive action, proper alignment under all operating conditions and provides maximum load carrying capacity.

▼

New Snogo Model TU Truck Unit

Klauer Manufacturing Co., Dubuque, Iowa, announces a new model in the "Snogo" line—a radical departure from previous designs.

Snogo Model TU is designed and adapted for mounting on standard FWD trucks. Both plow and motor are quickly and easily removable from truck, leaving truck free for other uses on short notice.

Plow is supported on front sub-frame which is adjustable, and which is bolted to front frame members of truck. In lifting or lowering, plow moves on sliding rails and is always in perfect vertical position.

Plow is quickly detached by removal of a few pins, which makes it interchangeable with push plows of various types, if desired, allowing the use of hydraulic lift gear with push plow.

Plow is equipped with hydraulic lift and hydraulic direction control of snow stream —both controls located in cab. End shoes and center shoes are equipped with alloy steel wear plates for economical replacement. Center shoes or runners are adjustable to hold plow at any predetermined distance from road surface. Weight of plow can be carried on these runners wherever desired.

Snogo motor is independent of truck motor, with direct drive to plow. Snogo motor is used only for plowing—truck motor is used only for propulsion.

Snogo motor is a complete power unit, mounted on separate skid frame which is clamped to truck frame and quickly removable. Plow clutch is mounted integrally with motor at forward end. When removed from truck, Snogo motor is a complete power unit, on skid frame of standard type and complete with clutch, radiator, hood and side panels, etc. Available for any desired power application.

The New Snogo Unit

▼

New Disc Sharpener

Employing an unusual principle of grinding action the Hargrave Construction Company of Cedar Rapids, Iowa, claims to have developed a solution to the tricky problem of sharpening heat treated, alloy steel discs used on devices for working oiled, bitulithic and asphalt pavements.

The disc is revolved at 500 to 1000 r.p.m., using 3 to 5 hp.; and the grinding wheel is held against it at such an angle as to turn the grinding wheel and at the same time give cutting action. The grinding wheel is spring-fed to the disc by turning a handle at the end of a control arm. The control arm swings horizontally on a pivot to develop approximately a three-inch radius of curvature of the ground surface, which is considered proper for sharpness and reinforcement of the cutting edge. The

The Hargrave Speed Disc Sharpener

pivot of the control arm is adjustable to suit various diameters of discs.

It is claimed for this sharpener that material removal is fast without danger of overheating the disc; that the sharpened disc is true to round and center; that a properly ground surface is easily developed under ordinary conditions and in average hands. The device is Timken equipped.

▼

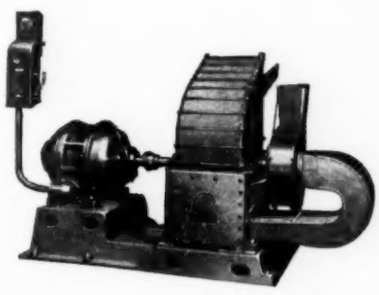
Hammer Mill Grinds Asphalt and Bitumen

The "Jay Bee" all-steel hammer mill, illustrated herewith, is used by Colprovia Roads, Inc., and by many other large firms in the industry, here and abroad, for grinding asphalt.

This grinder is especially constructed to reduce asphalt and bitumen. Its all-steel construction makes for great ruggedness, durability, and long life with a minimum of upkeep cost. The special steel swing hammers grind without heat or friction. The steel construction makes the mill light in weight and much stronger than any similar sized mill of cast construction.

Grinding capacities, using ¼ in. screen, will run from 4000 lbs. per hour, using 25 horsepower, to 8000 lbs. or more per hour, using 60 horsepower. It is made for both belt and direct-connected drives.

The "Jay Bee" mill is made by the Bossert Corporation, Utica, N. Y., and sold exclusively by J. B. Sedberry, Inc., 406 Hickory St., Utica, N. Y. Full information will be furnished our readers upon request.



The "Jay Bee" Hammer Mill

A Practical Turn-Signaling Device for Cars and Trucks

The Furan Manufacturing Co., Thief River Falls, Minn., announces a new safety device to replace hand signals for the making of left hand turns. The equipment

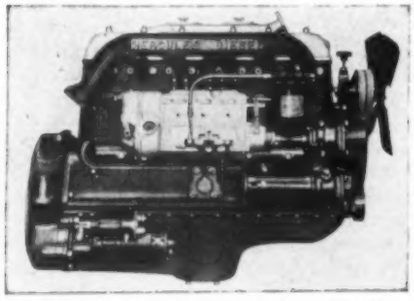
Furan Auto Turn Signal

is also adapted to the signalling of right hand turns when desired. The signal consists of an orange-colored hand mounted on a shifting frame above the visor or on the cowl below the windshield, where it occupies a small and inconspicuous space when not in use. When extended, it projects from 18 to 20 inches beyond the car body. It is operated by a small hand lever in front of the driver.

New Diesel Engine

Hercules Motors Corporation, Canton, Ohio, announces an addition to their line of six cylinder Diesel engines in their Model DRXB—3⅜ x 5¼ ins. This engine with a displacement of 474 cubic inches (7.77 liters) and an N. A. C. C. rating of 45.9 horsepower develops 120 horsepower at 2,000 r.p.m. and a maximum torque of 340 ft. lbs., this torque curve being exceptionally flat, varying but 40 lbs. from 600 r.p.m. up to 2,200 r.p.m.

This engine interchanges with the Hercules gasoline engines known as the "YX"



Model DRXB Hercules Diesel Engine

and "RX" series in installation measurements.

The engine is a full Diesel of the auxiliary combustion chamber type which controls the burning of the fuel and makes this engine very powerful for its displacement as well as smooth running, flexible and economical.

Both the crankshaft and camshaft are carried on seven bearings—the former being 3 ins. in diameter with 2⅝ in. crankpins and full floating piston pin of 1⅝ in. diameter.

Main and connecting rod bearings are removable steel shells lined with high-lead bronze, capable of carrying high pressure and temperatures.

As is the usual Hercules practice this model is also built into complete power units, either full enclosed or open types, such as are regularly used for oil field service, general industrial application and for —both pump and generator drive—likewise this model is converted for marine use.

In the pressed steel oil pan is provided a self-priming double scavenging oil pump, assuring ample lubrication with the engine operating up to as much as 45 degree angle off the horizontal plane. The oil pan capacity is 2½ gallons of oil.

As regards performance, it is stated that with brake mean effective pressure of 105 lbs. economy on fuel is very excellent, with the acceleration ability of comparable displacement gasoline engines, and due to the action of the auxiliary air chamber very complete and clean burning of the fuel is accomplished.

A New Low Cost Heavy Duty Trailer on Pneumatics

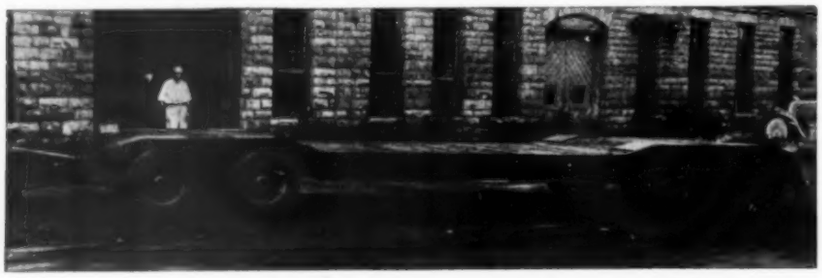
For some time the cost of suitable pneumatic tires has been a handicap to the large heavy duty pneumatic tired trailer. Recently a new tire which substantially lowers the cost of pneumatic tired trailers has been developed through the efforts of the C. R. Jahn Co., Builders' Building, Chicago, distributors of the LaCrosse heavy duty trailers.

The new pneumatic tired models of LaCrosse Tu-Way Trailers will be equipped with these new tires unless otherwise specified. The tires are heavy duty, 10 ply and have a capacity of 3600 lb. The diameter is less than 30 in. Wheels are stocky and of unusual strength, with demountable rims and Timken bearings.

With this design, the loading platform is less than 30 in. above the ground, permitting easy loading over the ends as well as over the sides, and makes possible the purchase of pneumatic tired equipment at a cost only slightly greater than solid tired equipment.

In addition to these new desirable features, LaCrosse Tu-Way Trailers have all the old ones. They can be towed from either end, load from either end or side, steer from either end, and have eight wheel brakes controlled from either end.

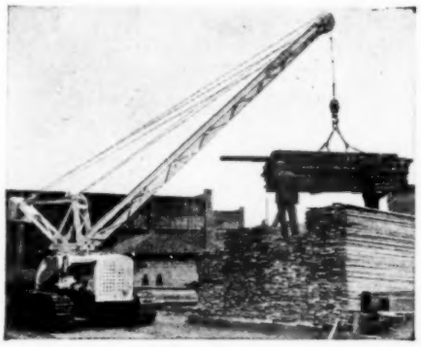
Further information can be obtained from the C. R. Jahn Co., Builders Building, Chicago.



LaCrosse Heavy Duty Trailer with Pneumatic Tires

Trebled Capacity, Mobility and Speed Feature New Loadmaster Crane

A mobile crane of the same rugged construction as Bucyrus-Erie excavators—with nearly three times the capacity of previous models—with the added advantages of exceptional mobility, ease of handling and fast crane-operating speed — has recently been announced by Bucyrus-Erie Company, South Milwaukee, Wisconsin.



The CT-50 Loadmaster

This crane, designated as CT-50 Loadmaster Crane, is powered with Caterpillar 50 Gasoline or Diesel engine, and mounted on modified "Caterpillar" tracks. It is provided with a 30-ft. boom and swings through an arc of 240 degrees. The lifting capacity is 13,900 lbs. at 12-ft. radius. Its ability to travel quickly and easily over uneven ground, plus the Bucyrus-Erie hydraulic stabilizers are important features.

The hydraulic stabilizers are mounted between the equalizer beam and heavy brackets cast integral with the machine frame, and provide maximum stability for the crane when operating over the side, even when machine is standing on sloping or uneven ground.

When the CT-50 Loadmaster is traveling, the equalizers are not set, and the caterpillar belts have their full oscillation. Caterpillar treads are 20 ins. wide and the long frames increase the stability of the machine when handling heavy loads.

New Liquid Stops Leaks in Concrete Walls, Floors, Etc.

A recent development in the field of waterproofing is Stonhard Stontite, a liquid material which stops leaks ranging from streams the size of a man's fist to occasional seepage.

This material may be used to waterproof foundations, walls, elevator pits, floors, tunnels, swimming pools, reservoirs, dams, aqueducts—in fact, anything constructed of concrete. Its application is simple and requires no special skill or experience. It is not necessary to remove the hydrostatic pressure, for Stontite is used on the free, or open, side of the structure.

Complete information and specific recommendations for individual applications can be secured from the Stonhard Company, 401 North Broad Street, Philadelphia, Pennsylvania.